THE

ELECTRICAL REVIEW.

VOL. XLVI. MARCH 9, 1900. No. 1,163.

CONTENTS:

	PAGE
The Fourth Arm of the Service	377
Becquerel Rays (*illustrated*)	379
On Electric Lighting Cable Breakdowns (*illustrated*)	380
The Advent of Cheap Electricity	383
Review:—Electric Power Transmission	385
Correspondence:—"The Working of Steam Engines under Variable Conditions"	385
Electrical Engineering in H.M. Navy	387
Penalties on Contracts	388
City and South London Railway Extensions	388
Presidential Addresses	388
Fire at the Maiden Lane Electricity Works	389
Legal	389
Business Notes	390
The County of London Electric Lighting Company's Electricity Works (*illustrated*)	397
Supply Station Accounts	408
City Notes	409
Traffic Receipts	412
Stocks and Shares	412
Share List of Electrical Companies	413
Market Quotations	414
The Action of Electric Tramway Currents on Submarine Telegraph Cables and other Electric Circuits (*illus*) (*concluded*)	415
Institution of Electrical Engineers: Manchester Branch	416
The Designing of Electrical Generating Stations	418
Electrical Volunteers for the Front	420
American Competition and State Help	421
Boiler Legislation	421
Electric Traction	421
Obituary.—Emile M. H. Andreoli	422
Open *v.* Enclosed Motors for Stationary Work	422
New Patents	423
Abstracts of Published Specifications	423

THE

UNIVERSAL ELECTRICAL DIRECTORY

1900

Edition

NOW READY.

H. ALABASTER, GATEHOUSE & CO.,

4, LUDGATE HILL, LONDON E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY. Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4 LUDGATE HILL, LONDON.

Telegraphic Address: "AGENCY, LONDON." Code A B C.

Telephone No. 988 Holborn.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To all *other countries*, per Year, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU 22, Rue de la Banque. *Berlin:* ASHER & Co, 13, Unter den Linden.

Cheques and Postal Orders (on Chief Office London, to be made payable to Mr H. ALABASTER, 4, Ludgate Hill, E.C.

THE FOURTH ARM OF THE SERVICE.

THE "send off" dinner to the active-service contingent of the Electrical Engineers (R.E.) Volunteers, which took place on Saturday evening last, and with which we deal at length in another page of this issue of the REVIEW, forms a theme on which to arrange some variations, and to concentrate further attention upon a branch of the service which has just come in for some unwarrantable, ill-advised and hasty criticism at the hands of *the* army reformer of the age; at least such would appear to be Mr. Bennet Burleigh's opinion of himself.

"The man in the street" is able to judge for himself of the merits of infantry, cavalry, and artillery, but to the great B. P. (not to be confounded with the daring and gallant defender of Mafeking), the fourth arm of the service, the scientific portion of our forces, exists in name only, and the very existence of what may be termed the brain of the army is now threatened by the ubiquitous critic of the all-powerful *Daily Telegraph*.

"One of the Army reforms somebody should turn their attention seriously to," says the English exemplar of that reformer of modern warfare, M. Bloch, "is the modification or the abolition of the Royal Engineer branch of the service. It is a startling proposition, but hear the plea therefor. As railway experts and telegraphists, they are neither as smart nor useful at the work as the trained specialists of civil life, who can always be obtained in time of war. The field companies of Royal Engineers absolutely stand in the way of doing that which every soldier should be taught to do for himself, promptly and swiftly, upon the field, *i.e.*, constructing trenches, rifle pits, walls, or whatever defensive or aggressive works may be requisite. Each infantry battalion carries trenching tools, a Scotch cart with 70 spades, and so on. These are ample for all ordinary purposes, but the knowledge that trenching is your Sappers' special job, delays ready resort to these implements. All ordinary field work the battalions should themselves be able to execute. Let there be 50 or 100 skilled men, chiefly accustomed to building operations, and a sailor or two included in each regiment. See that the men are trained workmen, and given a higher rate of pay upon enlistment. Most of them, no doubt, would soon rise to the dignity of corporals and sergeants, but that would be a further gain to the service and to their usefulness. Save for ballooning and one or two other highly technical branches connected with warfare, the big army of highly-paid engineers could be curtailed with profit to the Queen's service."

In a letter published in the *Daily Telegraph* on February 28th, Major-General C. E. Webber, R.E., quietly, yet forcibly, calls Mr. Burleigh to task:—

"If," says the gallant officer, "only academic, and consequent on his observation of a peace manœuvre, his remarks would not, perhaps, need comment; but made, as it were, in the line of actual battle, when the war and all about it from so able a pen is read with avidity, Mr. Bennet Burleigh's strictures must not pass unnoticed."

. . . . . .

"I need not refer to his strictures on the way the R.E.'s do telegraph and railway work in war. I could quote for his readers dozens of his eulogies on the other side both in 1882, 1884, and 1898.

"I leave to him and to the 'distinguished officers' who agree with him his remedy, namely, that each battalion should include a company of specialists, 'skilled men of the building trades, and a sailor or two' (from which company he admits most of the non-commissioned officers of the battalion would come). I don't think that his friends, the distinguished officers, with all their contempt for science, will back him up in anything so unscientific.

"May I conclude by remarking that the use of the word 'science' as applied to warfare has been strangely misunderstood. To most of

D

my contemporaries it has been, as long as I remember, like a red rag to a bull. The title 'scientific' has been a term of reproach. The truth is, the science of war is as old as history, and its broad principles never change. The leader with genius for war studies its application to all possible circumstances. Our failures in South Africa are entirely due to the absence of such study. The *rôle* of the engineer in war is to use the great forces of nature in their application to war, just as the *rôle* of the rifleman is to use his rifle. Each must be scientific in his own way. An army without engineers (the fourth arm), which your correspondent wishes to abolish, would be like a four-wheel carriage with three wheels. Similarly, a nation without a general staff capable of studying the science of war is minus one lobe of its brain. For instance, if our general staff had studied warfare in South Africa from its past records they would never have sent foot soldiers to oppose mounted riflemen. The appreciation of this last and other fundamental *méthodes de guerre* is the direction for 'reform' which I should have expected your correspondent, with his wide experience, would have advocated, instead of advocating the abolition of the 'branch' which has to undertake every combatant *rôle* in war that is not included in those of the rifleman, the gunner, and the man who fights on horseback."

Now, this example is typical of the abuse, not the use, in which the freedom of the English press enables its writers and correspondents to indulge.

Nearly every newspaper in the kingdom lauded Mr. Chamberlain's bold and patriotic attitude to the skies, before the announcement that hostilities had commenced; a few months later he was the most abused statesman in the country. The criticisms directed at the War Office may possibly have some justification in fact, but these we will not attempt to discuss.

When Lord Methuen defeated the Boers at Belmont, Graspan, and the Modder, his generalship was of the right sort. He went for the enemy in the old fashioned English manner, and for a brief period his star was in the ascendant. When he was pulled up short at Magersfontein, and remained for weeks more or less inactive, he was reviled and heckled in a way the gutter press of Paris would find it hard to beat.

Buller went to the front with the eyes of the nation fixed upon him, the saviour of old England, the idol of the British pressman. The vituperation heaped on his devoted shoulders during the long series of attacks and repulses which preceded the relief of Ladysmith was enough to break the spirit of a man of less iron will. Now the tide has turned, and "Old Buller," as his men affectionately speak of him, is rehabilitated in the eyes of his newspaper censors.

Our artillery has been mercilessly condemned as obsolete and useless by some who have been unable to differentiate between guns of position and field batteries, and by others who confound the calibre of a gun with the weight of its projectile.

Evening papers have gone so far as to offer prizes of one guinea for the best letter emanating from poor Tommy Atkins, and as we have read many of these precious effusions, which ought never to have seen the light of day, criticising and questioning the conduct of the operations entrusted to their commanding officers, it does not require much prescience to come to the conclusion that that strict regard for discipline which has hitherto been so characteristic of the British soldier, is in danger of being lost, and the confidence in his officers, which has led to so many victories over our foes throughout the world, seriously lessened.

Even Mr. Bennet Burleigh cannot refrain from harping on this topic, as we notice (in a contemporary) that he sent an excellent letter from Chieveley, dated February 9th, *i.e.*, after Potgieter's Drift, which indicates very clearly the difficulties with which General Buller had to contend amongst his own followers, and affords anything but a satisfactory picture of the discipline of the "intermediate grades" of our officers.

Surely these deviations from loyalty to one's superiors in the army should not be paraded before the public, but left to be dealt with by the military authorities in their own way.

Every detail of what is going on in the English camps, war correspondents' suggestions of what our generals *ought* to do, are fully and freely tendered to the Boer emissaries, both here and on the Continent, and if at any time the Pretoria and Bloemfontein Governments have lost touch with any particular British movement, it has not been the fault of newspapers or of their correspondents at the front.

If the censorship over Press telegrams could but have been still more rigorously enforced over newspaper articles as well, it would have been all the better for the ultimate success of our armies, whose so-called friends at home are more to be feared than their foes in the field.

Naturally there have been honourable exceptions, and it gives one pleasure to read the sensible, level-headed, impartial, and almost judicially minded articles in such papers as the *Standard*, *St. James's Gazette*, and a few others.

Let the infantry soldier be taught to take better care of himself by all means, but to flippantly suggest the abolition of the fourth arm of the service is an insult to those officers and men who represent the highest scientific and technical attainments in the army of which we Englishmen are so proud.

"Ballooning and one or two other highly technical branches connected with warfare," form but a tithe of what constitutes the duties of the Royal Engineers, and if Mr. Bennet Burleigh and his compeers had but a fraction of the technical training of the men he so ruthlessly falls foul of, we should be treated to concise statements of fact in place of the column upon column of useless ink-slinging which passes muster with the masses as brilliant writing.

Finally, lest we forget, may we remind the would-be destroyer of the fourth arm of the service, that Lord Kitchener is a Royal Engineer. And was it not the railway, so rapidly laid and equipped under the supervision of the young and energetic officers of the Royal Engineers, which enabled the victor of Omdurman to completely break up the Khalifa's rabble at almost the precise hour he had calculated upon months before? We venture to hope that the Electrical Engineers (R.E.) Volunteers, who are about to leave our shores, will show their usefulness in ways as yet unknown to Mr. Bennet Burleigh, and induce him to withdraw his sweeping condemnation of those men whose work by its very nature, equally useful though it be, does not appeal to the public in the same way as a brilliant infantry onslaught, a dashing cavalry charge, or a pounding artillery duel.

Our wars will not necessarily be confined to fighting Transvaal peasants, or Indian hill tribes; possibly before this year comes to a close, we may be engaged nearer home, and then we shall have need of all the brains the Royal Engineers can bring to bear upon the methods of a warlike people who, while they ought to live on terms of the most intimate friendship with *perfide Albion*, are dying to engage us in a war, compared with which the Dutch rebellion is but child's-play.

Fashoda still lives in the memories of our Gallic neighbours, and, as a Secretary of Embassy has recently said, "France may forgive Germany the powerful, but never the wound to her *amour propre* which she has suffered from England."

Sir H. M. Stanley, however, does not regard the strained relations between the two countries seriously. Here, in England, says the great African explorer, we have a weakness for France, whom we regard very much as a pretty woman who has frequent fits of temper. "There will never be war," he said to the London correspondent of the *Journal*, "between France and Great Britain, unless you attack us."

With the recollection of last year's B.A. meeting at Dover, and the interchange of courtesies between the English and French men of science, the technical press of both countries might combine to foster the good feeling which exists amongst the better class representatives of both nations, and so help to counteract the baneful influence of the gutter press upon the ignorant.

BECQUEREL RAYS.

If it had not been for the previous discovery of the Röntgen rays, the discovery of the Becquerel rays would have been looked upon as the most remarkable scientific event of the century. These rays have many of the now well-known properties of the Röntgen rays, but in their origin

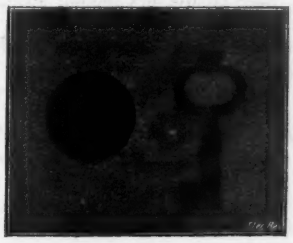


Fig 1.

they are unique, since they appear to contravene the law of the conservation of energy and realise the popular ideal of creation of something out of nothing.

A photographic effect, due to the presence of sulphide of zinc, was observed by Henry in 1896, but he supposed that the effect was due to a transformation of the Röntgen rays to which the sulphide of zinc was at the time exposed. Becquerel was the first to show that the photographic effect was due to radiation proceeding from the substance itself, even when the Röntgen rays were not present, and he also showed that a great many other substances besides sulphide of zinc emitted this peculiar kind of radiation. These rays are, therefore, properly named after the real discoverer, Becquerel.

The Becquerel rays, like the Röntgen rays, have the property of passing through all substances, whether opaque or not, the absorption being proportional to the specific weight of the substances. Fig. 1, for instance, is a diagraph of a key and coin enclosed in a cardboard box, obtained by exposure to the Becquerel rays. The result is much the same as would be produced by the Röntgen rays; the exposure required is longer, and the outlines are not so sharp, especially if, as in the case of the key, the object is some distance above the photographic plate.

The substances which Becquerel first employed to produce this radiation were the phosphorescent compounds of uranium, that metal which, of all the chemical elements, has the highest atomic weight. Later he found that non-phosphorescent compounds of this metal emitted more or less strong rays of the same kind, and he came to the conclusion that the radiation was probably due to the presence of the metal, and that the pure metal would emit more powerful radiation than any of its compounds. This expectation was fulfilled, and Becquerel on that account called the new radiation "Uranium rays," a name which, however, can hardly be justified, since other substances not containing uranium have since been found, which are even stronger radiators. Of such substances may be mentioned thorium, which comes next to uranium in atomic weight, and is well known as forming an essential constituent of the mantle of the Welsbach gas light.

The discovery of this property of thorium and its compounds was independently made by Schmidt, of Erlangen, and Madame Curie, of Paris, a lady who soon after distinguished herself by making further discoveries in this field. We have her to thank, especially, for the discovery of two entirely new groups of preparations, whose Becquerel radiation is some hundred times stronger than that of the uranium and thorium compounds previously known. While comparing the strength of the radiation of uranium and thorium compounds, Madame Curie discovered that Bohemian pitchblende, a uranium ore, had a much stronger action than uranium itself, and, in view of Becquerel's investigations, this could only be accounted for by the presence in the ore along with the uranium of another more active element. By fractional analysis of the pitchblende, the most active constituents were gradually isolated, and there turned out to be two such products in the ore. Chemical analysis showed that these two products were compounds of bismuth and barium respectively, but with this difference that the same compounds obtained in other ways did not emit Becquerel rays. The products were looked upon by their discoverer as two new elements, and were named by her "Polonium," and "Radium." The probability, however, is that they are merely allotropic forms of compounds of bismuth and barium; but judgment for the present must be suspended on the question of their elementary character. It has been proposed by Giesel to call them simply "radio-active bismuth," and "radio-active barium."

Fig. 2.

Fig. 3.

Giesel, of Brunswick, with the assistance of the well-known

physicists, Elster and Geitel, has succeeded at the chemical factory of A de Haën of List, near Hanover, in making concentrated preparations of the substances discovered by Madame Curie, which far exceed in radio-activity anything that has hitherto been produced. The most powerful substance obtained by Giesel requires that some hundredweights of the ore should be used for the production of a few grams, which, of course, makes its cost prohibitive for professional or commercial use, but the De Haën factory manufactures an intermediate product, which, though not quite so powerful, can be had at a moderate price.

The immense improvements that have been made in radio-active substances by these investigations has suggested the possibility of replacing the costly apparatus for the production of Röntgen rays, by a small tube charged with one of these preparations. This question is of especial interest to medical men; and it has recently been thoroughly investigated by Dr. Walter, of Hamburg.*

Both the De Haën and the Giesel preparations are capable of exciting the barium platinocyanide phosphorescent screen. The effect is very much weaker than with the Röntgen rays, but with the Giesel preparation the phosphorescence is distinctly visible at a distance of 20 cm. A shadow picture of the human hand can be obtained, but only the outline of the hand is seen, the bones are invisible. Even when the photographic plate is used, the bones are not shown, as may be seen by comparing photographs 2 and 3. 2 is taken with the Röntgen rays, 3 is a photograph of the same hand taken by an exposure of an hour to the strongest Giesel preparation. The bones are invisible in the second case; a needle and coin placed under the hand are visible, but indistinct compared with the Röntgen photograph.

These results dispel all hope of using the radio-active substances for obtaining diagraphs of parts of the human body. Walter's investigation leads to the conclusion that the failure of the Becquerel rays to depict the interior parts of opaque bodies is due to their greater diffusion, and to their exciting secondary radiations in the substances through which they pass. The secondary radiations act on the photographic plate and obscure the outlines of the interior forms.

Though Walter's investigations lead to a negative result, they are not the less valuable in preventing users of the Röntgen rays being misled by the many similarities of the Becquerel rays and the X rays into the belief that the latter can in every case replace the former.

ON ELECTRIC LIGHTING CABLE BREAK-DOWNS.†

Very soon after the first alternating current central stations were built, experience showed that, when individual portions of a network of concentric cable were switched in or out, a danger arose of the insulation breaking down between the outer conductor and the lead sheathing. It was also recognised that this danger might be obviated by conforming to the rule formulated by Neufeld, viz.:—

First switch in the outer conductor.

First switch out the inner conductor.

The cause of the danger, as well as the means for the avoidance of the same, have been treated by different authorities, both theoretically and experimentally. In this connection may be cited the experiments of Alexander Siemens on the influence of the capacity of cables on the ratio of transformation of a transformer, and Prof. Fleming's experiment on two mains of the Deptford central station in London. Feldmann, too, has exhaustively treated these experiments and the theory of these phenomena in his excellent book on transformers. I might, therefore, assume that these phenomena, and cable breakdowns connected therewith, are well known, and pass at once to the real subject of this article, which refers to cable breakdowns of a totally different description, the cause of which has not been explained hitherto.

I am aware, however, from my own experience, how easily one forgets theoretical explanations, and in order to spare the reader the trouble of looking up and familiarising himself once more with the old explanations, and also to preserve their connection with the phenomena which will be described later on, I may here briefly explain the cause of the breaking down of cables whose inner conductors remain switched in while the outer is interrupted.

Let us consider a high tension network of concentric cable, at the junction-points of which transformers are connected. Each transformer can be considered as an apparatus through which both a watt and a wattless current can flow. If the load on the low-tension side be very great, and if the phase-displacement be zero (*e.g.*, where only incandescent lamps are connected to the secondary), the ratio of wattless to watt current will be very small, and the coefficient of self-induction of the transformer—which we are looking upon merely as an apparatus capable of allowing a flow of current through itself—is likewise very small. The smaller the load, the greater does the self-induction become, reaching its maximum at no load. It is also clear that in all cases where the load on the secondary network is inductive (*e.g.*, where not only incandescent lamps, but arc lamps and motors are in circuit as well), the self-induction of the transformer is greater than when the load is non-inductive.

We can therefore consider the transformer as an apparatus of which the inductance ωL is not constant, but depends on the nature and amount of the load on the secondary and on the terminal voltage. This apparatus possesses, besides inductance, resistance, the amount of which latter also depends on the load.

If now the outer conductor of any length of cable be interrupted at the near end only, it will become charged from the transformer situated at the far end with which it is still connected.

We can calculate the charging current from the capacities of the disconnected portion of the outer conductor, and the remainder thereof respectively.

Let C_1 be the capacity of the disconnected portion of the outer conductor to the lead sheath (which is the same as to earth, since the lead sheathing is metallically connected with the junction boxes), and C_2 be the capacity to earth of all other portions of the outer conductor not disconnected. The current circuit will be as follows:—From the inner conductor bus bar in the central station to the coil (representing the transformer), thence to the portion of the outer conductor which is connected thereto, but isolated from the remainder, thence through C_1 to earth, from earth through C_2 to the whole network of outer conductors, and thence back to the other bus bar in the central station.

The two capacities, C_1 and C_2, are thus in series. For these we can substitute a single capacity, C, according to the well known formula

$$C = \frac{C_1 C_2}{C_1 + C_2}$$

If C_2 be very great compared with C_1, we have approximately

$$C = C_1.$$

The outer conductors of the whole network behave as though they were earthed, and the insulation of the disconnected portion must withstand the whole voltage of the capacity current. This voltage, however, can rise considerably in consequence of resonance effects, and herein lies the danger of a breakdown in the disconnected portion of the outer conductor.

To form some idea of the extent of this danger, we will take as an example a network for a town consisting of 100 km. of high tension concentric cable. Let the primary working voltage be 3,000, the frequency 45; the capacity of the outer conductor to the lead sheathing depends on the constant of the insulating material, the thickness of the same, and the cross-section of the cable. Without entering upon any tedious calculation in reference to some particular installation, we can assume that the capacity averages 1 microfarad per kilometre. We will further assume that the transformer which is still connected with the partially-insulated cable is rated at 20 kilo-

* *Fortschritte auf dem Gebiete der Röntgenstrahlen*, Vol. 3, p. 1.

† Translation, by M. B. Field, of article entitled "Ueber Kabeldurchschläge," by Gisbert Kapp (*Electrotechnische Zeitschrift*, December 28th, 1899).

watts, and that the power factor of the secondary circuit is 0·9. The power factor of the coil (which we are substituting for the transformer) will not be much less than 0·9 for all loads until we come into the neighbourhood of the no-load current, when the power factor will be considerably less.

The inductance can be calculated from the data of the transformer, and it is further possible to calculate under what conditions this inductance, combined with the capacity of the disconnected portion of the outer conductor, will give rise to dangerous resonance effects.

There are two cases which must be differentiated :—

(*a*) When the transformer is connected to the far ends of both conductors of a length of cable constituting a feeder, the near end of the outer conductor being interrupted.

(*b*) When the length of cable forms a side of a mesh of the network itself in such a manner that the inner conductor is connected to transformers at both ends, the outer conductor only at one.

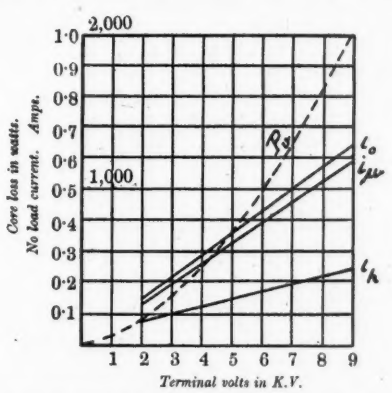
The difference between the two cases is that in (*a*) the terminal voltage of the transformer can rise or fall, while in (*b*) the normal value of the volts must be maintained so long as all the transformers remain connected through the secondary network.

We will now consider case (*a*), and assume that the secondary cables are only connected to the transformer situated at the end of the feeder, and are independent of all the other secondary cables of the town network; in fact, that the lighting circuit is, in a sense, confined to an isolated area. A general mathematical treatment of this case is possible, though the same would not be very explicit. The treatment of a particular case is, therefore, more advantageous. We will accordingly take the 20 kilowatt transformer as above, and assume that with 3,000 volts the no-load current is $3\frac{1}{3}$ per cent., or, roughly, 0·22 ampere, and that the iron loss amounts to 300 watts.

The easiest method of examining the case will be for us to assume various values of the terminal voltage, and determine in each case that capacity for which the necessary charging current is exactly equal to the primary current corresponding to the assumed terminal voltage, but in each case we must take the generator voltage (which is the impressed voltage of the combination of transformer and capacity) as 3,000, *i.e.*, we assume it to be constant.

This corresponds to actual conditions, since the generators in modern central stations are so large that their terminal voltage remains to all intents and purposes unaffected by the occurrences under discussion.

Let us first take the case where the secondary network at the end of the feeder is unloaded. Such a case would be one in which the feeder conveyed current for a residential district, where at given times there would be no demand either for lighting or power. A case could also arise where the secondary network was switched off from the transformer to permit of a fresh connection being made.



20 K.W. transformer; 3,000 volts; 45 ~; 300 watts core loss; $3\frac{1}{3}$ % no load current.

Fig. 1.

Knowing the magnetic properties of the transformer iron it is possible to calculate the no-load current and losses, and hence the phase-displacement of the no-load current for each value of the terminal voltage. The calculation is so simple that it is unnecessary to go through it in detail. Fig. 1 shows graphically the data for a certain kind of iron. P_p here represents the core loss on no-load, i_o the no-load current, i_h and i_μ respectively the watt and wattless components of the same. P_p does not take account of the copper loss since the latter is inconsiderable.

The following is the procedure for determining the value of the capacity corresponding to any given terminal voltage, *e.g.*, 3,500 volts. Draw O A = 3,500 (fig. 2) to any

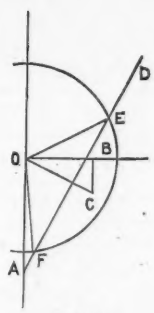


Fig. 2.

convenient volt scale, and O B = 0·23, which is the wattless component of the no-load current taken from diagram I, to any convenient current scale—O B is at right angles to O A—B C the watt component (of the no-load current) is parallel to O A. In our case B C = 0·11, O C represents the no-load current, and will be, of course, at right angles to the vector representing the condenser voltage.

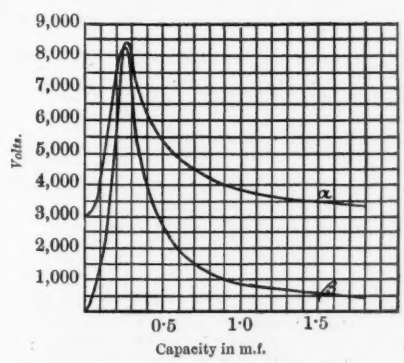
This condition determines the position of the vector, A D, while its length is determined by the fact that the generator voltage is 3,000. If, then, from centre O we strike out a circle of radius = 3,000 volts, the two points of intersection, E and F, with the straight line, A D, are situated at the two angles of a triangle of electromotive forces, of which O A, the side common to both, represents the assumed transformer terminal voltage of 3,500. The potential difference between outer conductor and sheathing is either

$$A\,E = 5{,}700 \text{ v.}$$

or

$$A\,F = 575 \text{ v.}$$

Any other value is impossible with a terminal voltage of 3,500 at the transformer. The capacity of the outer conductor to lead must, however, be a definite amount in order



α = Terminal voltage of transformer.
β = Voltage between outer and lead.

20 K.W. transformer; $3\frac{1}{3}$ % = no load current; 300 watts = core loss; 3,000 volts; 45 ~; transformer on no load; outer conductor connected at far end to transformer, at beginning interrupted.

Fig. 3.

that the one or the other of the two above values holds. As is well known the charging current is

$$i = \omega\, C\, e\, 10^{-8}$$

Hence, in our case

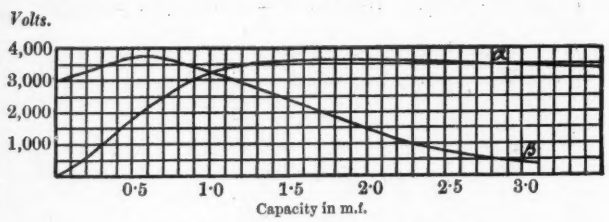
$$0{\cdot}26 = 282\ K\, e\, 10^{-8}.$$

E

The capacity K, in microfarads, can be reckoned from this formula. It is for

$$e = 5{,}700 \qquad c = 0{\cdot}161$$
$$e = 575 \qquad c = 1{\cdot}60.$$

The capacity corresponding to any other terminal voltage can be determined in a similar manner. Each value of the terminal voltage greater than 3,000 gives two values for the capacity; to the smaller corresponds the higher value of the



α = Terminal voltage of transformer.
β = Voltage between outer and lead.

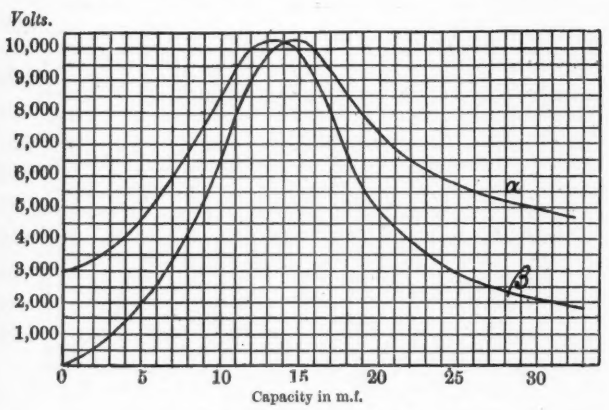
20 KW. transformer; no load current = 3⅓ %; core loss = 300 watts; 3,000 volts; 45 ~; transformer on $\frac{1}{10}$th full load; cos ϕ (secondary) = 0·9. At rear end of feeder only inner conductor connected to current source, outer conductor interrupted. At far end both conductors connected to transformer.

FIG. 4.

potential difference between outer conductor and lead sheathing while a lower value of potential difference corresponds to the higher value of capacity.

The value of the capacity is infinite for a terminal voltage of 3,000. This is instructive, since an infinite capacity is equivalent to a short circuit between the outer conductor sheathing, and outer bus bar.

In this case the points A and F in the diagram coincide, since the voltage between outer conductor and lead is zero. Strictly speaking, this is an impossible case with an insulated outer conductor, since the capacity cannot be infinite. It can, however, occur if we earth any point whatever of the outer conductor, *e.g.*, a point in the central station. A convenient means is thus afforded for avoiding the danger of a breakdown. A F becomes negative for smaller values of the terminal voltage than 3,000, *i.e.*, the capacity must be nega-



α = Terminal voltage of transformer.
β = Voltage between outer and lead.

20 KW. transformer connected to end of feeder; transformer supplies 20 H.P. motor; inductance of motor with cos ϕ = 0·8 equivalent to inductance of 270 = ω L in primary winding. It is assumed that cos ϕ = 0·3 on starting, and that the fuse melts at beginning of outer conductor. No load current of transformer = 3⅓ %. Core loss = 300 watts = 1½ %. Motor is only load on transformer.

FIG. 5.

tive, in other words a self-induction, which is, of course, impossible. For these values A E alone is to be considered. The curve in fig. 3 is obtained by constructing the diagram for different values of the terminal voltage and plotting the results. The abscissæ represent capacity and the ordinates the tension between outer conductor and lead sheathing.

The curve for the terminal voltage is also plotted for the sake of clearness. A correction ought really to be made to take into account the fact that c_2 is not infinitely small compared with c_2, in fact, that $c < c_1$. As, however, it is practically immaterial whether the voltage between outer and sheathing amounts to 5,000 or 5,100 volts, both being alike dangerous, we will neglect the correction.

As is well known, the capacity of a concentric cable may be calculated from the formula

$$c = \frac{0{\cdot}024\, e\, l}{\log. \frac{R}{r}}$$

where e is an electrical constant (from about 3 to 4·5, according to the insulating material);

where l = length of cable in kilometres;
" r = outer radius of the outer conductor;
" R = inner radius of the lead sheathing.

According to our supposition that the feeder supplies only a 20-kilowatt transformer, the cross-section of each conductor will not need to be greater than 16 square mm. The capacity of such a cable is of the order of 0·6 microfarad per kilometre. If we consider as dangerous potential differences above 5,000 volts between the outer conductor and sheathing, we see from fig. 3 that the dangerous capacity lies between the limits 0·13 and 0·35 microfarad, whereas the dangerous length of cable between 215 and 580 metres, 420 m. is the most dangerous length of outer conductor, since the latter will then be subjected to a voltage over 8,000 volts.

The idea is generally spread abroad that no danger of breakdowns exists with multiple core cables (*e.g.*, two or three core cables), but this is not the case; the danger is, indeed, less, though not entirely non-existent. The multiple core is distinguished from concentric cable in that the insulation of all the conductors of the former is equally good, and secondly, by its much smaller capacity. A cable manufactured for 3,000 volts must be able to withstand a test of 6,000 volts, and will probably stand still more. The outer conductor of a concentric cable could not be expected to stand so great a strain. It is not easy to reckon the capacity to sheathing of one conductor of a multiple-core cable on account of the shielding effect of the other conductors. The capacity would certainly be much less than that of the outer conductor of an equivalent concentric cable. If it were, for example, only one-fifth, then assuming the dangerous voltage limit to be 6,000 volts, the critical length of a feeder consisting of a two-core cable would lie between 1,400 and 2,000 metres. With either a longer or shorter feeder, there would be no fear of a breakdown on interrupting one of its conductors at the beginning. If, on the other hand, the length of the feeder happens to lie between the limits given above, the case at once becomes dangerous, unless, indeed, both conductors be switched in or out at the same time, when the danger is avoided.

Now it is possible that in consequence of a short circuit in the secondary network, the fuses melt and isolate the same, and simultaneously one, and not both, of the fuses at the beginning of the primary cable melts, thereby giving rise to a dangerous condition. Hence, a multiple core cable is not absolutely safe from the danger of breaking down if one does not take the precaution of inserting fuses of considerably greater carrying capacity at the beginning than at the end. Concentric cables can be safeguarded by inserting no fuse in the outer, so that only the inner conductor can become interrupted.

Considerably more favourable conditions obtain where the secondary network at the end of the feeder is loaded. Even a very small load is sufficient to obviate a dangerous rise of voltage between the outer and lead sheathing, should the former become interrupted. Fig. 4 gives curves showing the transformer and outer conductor voltage on the assumption that one-tenth of the load is connected to the secondary, and that the power factor of the secondary circuit is 0·9. The curves are obtained by employing the construction given in fig. 2, with the single difference that now O C not only represents the no-load current, but the resultant of the no-load and the load currents.

From fig. 4 it is evident that the maximum voltage of the outer conductor is 3,800 volts, which occurs with a feeder

consisting of about 1 km. of concentric or 5 km. of two-core cable. This cannot be considered dangerous. The reason why the danger is very much diminished by even a small secondary load is, that the secondary phase-displacement is so small—($\cos \phi = 0.9$).

Now since a small phase-displacement diminishes the danger, one would suppose that a large phase-displacement would increase it. This is in reality the case. Let us assume that the feeder is employed for supplying a motor instead of lighting a residential district, and, further, that the motor, which is fed from the 20 KW. transformer, has a power factor of 0·8 on full load. Its inductance will be equivalent to an inductance of 270 inserted in the primary circuit. Let the power factor at starting be 0·3.

If the fuse at the beginning of the outer conductor goes as soon as the motor starts up, it gives rise to a dangerous condition. The voltage curves for this case are shown in fig. 5, being obtained by a similar process to that previously described. The dangerous lengths of the feeder are now considerably greater than heretofore. For medium distances multiple core cables are quite safe, and concentric cables may be protected by not inserting fuses in the outer conductors.

(*To be continued.*)

THE ADVENT OF CHEAP ELECTRICITY.

It may be declared without hesitation that in this country no progress has been made in electrical engineering without the most strenuous efforts on the part of engineers and those associated with them. No forward movement of any kind can be made without reference to Parliament and to municipal authorities. Private individuals cannot undertake a public service of electricity without the consent of municipalities, after which they must satisfy a Government department, and finally the scheme has to run the gauntlet of Parliamentary criticism. In endeavouring to bring electric tramways into districts into which they could never be introduced without private enterprise, corporations and urban authorities must be fought, propitiated and cajoled, not always because the rights and privileges of municipalities are threatened, but mainly for the reason that it is not considered good for individuals to make money by operating or directing public works. No doubt many opponents to private lighting and tramway schemes would deny that they were actuated by any such feelings, but it is difficult to come to any other conclusion. Not for a moment would we favour a condition of things under which private companies and individuals could carry out their schemes without let or hindrance, but there is a great difference between such a state of affairs, and one where encouragement rather than repression prevailed. We know that it is a common argument with advocates of municipalism that electric lighting companies are less inclined to extend generous treatment to consumers than usually prevails with municipal undertakings. But the position of supply companies ought to be clearly understood before admitting such a contention. When London was parcelled out among the various companies, the principle was laid down and accepted, that at the end of a stated term of years it would be permissible for the local authorities to step in and purchase such undertakings, or part thereof, as were in the districts affected. Without anticipating the trouble and confusion that will arise when the legal terms of provisional orders expire, we should like to point out that there was no sort of rigid monopoly granted to the London electrical supply companies, hence we witness in some parts of the metropolis the spectacle of three, and sometimes four, companies competing against each other. But there is no instance of a vestry which is carrying on a public supply of electricity being in competition with any other authorised undertaking. They may be somewhat hampered by having a limited term of years in which to pay back borrowed capital, but their works are not threatened with confiscation. It is this fact which may in a great measure account for the companies in London keeping up the price of electricity; it may be a bad business policy from some points of view, but shareholders' dividends and the short term of existence are no doubt powerful factors in the minds of directors. In comparing, therefore, a municipal electrical system and one carried on by a private company, these are matters which cannot be overlooked.

Leaving this aspect of the subject for a moment, however, we want to draw attention to the anomalous and curious condition in which electrical engineering is in this country at the present moment. The public supply of electricity commenced more than 15 years ago, but what sort of progress have we made? It is true that most large towns possess a system of electric lighting, but they are for the most part confined to furnishing electricity to shops, hotels, clubs, and to the houses of the better classes. Take the case of Bradford, which possesses one of the most successfully operated municipal works in the country. The management of this system has been exceptionally good, and in the cultivation of a motor load there has been a good deal of enterprise and skill exhibited. Yet, after an existence of nine years, in spite of being the centre of one of the largest industries of the country, it has only an equivalent of 94,000 lamps connected, and the total capital expenditure does not exceed £166,000. Similar remarks could be applied to most other towns; indeed, one may safely say that there is not a single comprehensive scheme of electricity supply in the whole country. How is it, therefore, that there has not been a greater degree of development; it may arise in some measure from the tentative and hesitating manner in which the subject has been taken up by municipalities, but more than anything the comparatively high prices have militated against rapid extensions. Not for a moment do we wish to disparage the municipal management of electricity works; in many cases they are, as far as production is concerned, models of economy, but we very much doubt whether the organisation of a municipality lends itself to the adequate development of so vast a business as electricity supply. In other words, there seems to be a limitation to the capacity of a municipality in carrying out great public works of the nature of electricity supply.

In the matter of electric tramways there has been a still greater degree of stagnation even than in electric lighting. One of the first tramway systems operated by electricity was carried out in the British Isles, and the City and South London Railway was the first electric railway in the world. But in what manner have we utilised this early experience, an experience which demonstrated beyond all cavil the economy of electricity? Not by giving in all directions the benefits of electric tramways, rather have we seen the world benefit by much of our experience, while we in the meantime have waited. America with its peculiar conditions was probably better fitted to utilise this agency, and did so in a marvellous manner. But it was not altogether due to the freedom from legal restraints which a new country frequently possesses, for Germany with its paternal form of Government and its bureaucratic control of towns is miles ahead of us. When one considers the experience and knowledge of our engineers, the readiness of the public to invest in sound undertakings, some very strong reasons are needed to account for the neglect of electricity as an agent for working tramway. Sentimental objections against overhead wires may have slightly retarded the introduction of electricity, but municipalities are chiefly responsible for our backward condition in this respect. Assuming that municipal ownership of tramways is the right thing, probably one ought not to attribute the whole of the delay to them, but the fact that they refused in most cases a renewal of leases to tramway companies prevented the earlier introduction of electrical methods, because the short period which most leases had to run, prohibited an expenditure on new plant. This is hardly the occasion to discuss whether a municipality is well fitted to own and control an urban and suburban system of tramways, but in spite of the fact that Liverpool and Manchester have been able to arrive at some working arrangements with local authorities outside the city boundaries, we doubt how far such examples will be followed. At any rate, drainage and sewage schemes of joint authorities have provided endless struggles and litigation between them.

One of the most striking results of this delay in equipping existing tramlines, and constructing new ones for electrical working is, that few of our manufacturers are able to supply tramway plant and apparatus, and in most tramway systems

in course of construction, a good deal of the machinery is being obtained from America. There is more than that, however, due to the slow progress, not only in tramways, but in light and power and chemical operations; English electrical manufacturers, in spite of their experience and wealth, are infinitely behind American and Continental manufacturers, and the consequence is seen in the great amount of machinery which is being imported into this country. It is a little humiliating to our national pride that after holding pride of place as steam engine designers and builders, we should be compelled to take a lower rank on the question of electrical machinery. It is not that our dynamos are inferior in design and workmanship to those made in other countries; on the contrary, we believe that our direct current plant and single-phase alternators have no superiors in the world. But the causes that have retarded the wider use of electricity have also prevented the development of our electrical workshops, and consequently the demand for special plant, such as tramway generators, car motors and controllers, finds us unprepared. It is only to be expected that the manufacturers of America, after building 20,000 miles of electric tramways, should be in a condition of standardisation and able to deliver tramway material promptly. There are many consulting engineers and buyers of plant who would infinitely prefer to use home-made goods, but they say it cannot be obtained, and they are compelled to go elsewhere. Probably English contractors may be eventually in a good position to supply tramway plant, but there is a tremendous leeway to make up before they can rank side by side with foreign competitors. The position is not altogether due to faults of our manufacturers; it arises partly from over legislation and the development of municipalism.

The necessity of the moment is cheap power, and only by its introduction can our industries hope to compete with those of foreign countries. Indeed, as the *Times* said a few days ago, "the subject ought to be approached by every responsible person with a clear understanding that the supply of electric power to our manufacturers at the cheapest possible rate, by some one and in some way, is essential to the preservation of our national power to compete in the markets of the world." We witnessed last year very strenuous efforts to introduce schemes which had for their object the supply of cheap electric power throughout various districts. Probably the most prominent was that known as the General Power Distribution Company's scheme, which sought to supply power through a large manufacturing area in South Yorkshire and Nottingham. It was strongly supported by some and opposed in deadly earnest by other municipal corporations.

The conclusions of the Joint Committee are worth reproducing here, especially having regard to the defeat of the Bill on the second reading. "Where (says the Committee) sufficient public advantage is shown powers may be given for the supply of electric energy over an area including districts of numerous local authorities and involving plant of exceptional dimensions and high voltage . . . . . on conditions differing in some respects from those imposed by and under the existing Acts . . . . . to undertakers supplying energy wholesale to other undertakers . . . . The evidence shows that the application of electric energy in the form of power to an infinite number of purposes is likely to be in the near future the predominant feature . . . . It does not appear (to the Committee) that an undertaking supplying energy in bulk at high voltage and in comparatively few mains is, as a rule, so desirable for the local authority to acquire as a low voltage undertaking with many distributing mains." This is a clear recognition of the value of the company's proposal, but in spite of this marked approval the House of Commons rejected the measure, not, however, because it did not agree with the usefulness of the proposals, but because it threatened an attack upon the interest of the municipalities. It was a dubious proceeding on the part of the promoters of the Bill to try conclusions, even indirectly, with municipal interests, because it was obvious that Parliament would not sanction any scheme which in the remotest way threatened Corporation undertakings. We admit the House of Commons showed a degree of wisdom in protecting the municipalities, because whatever merit a scheme might possess from some points of view, it was not altogether desirable if it threatened injury to the ratepayers.

Fortunately the defeat of the General Power Distribution Company's Bill, though disappointing no doubt to its sponsors, has not deterred applications to Parliament for power to generate and distribute electricity in various parts of the country, and what is of supreme importance to the electrical industry, the proposals were received with sufficient favour to enable them to pass the second reading last week. The schemes in question were to generate and distribute electricity in South Wales, in Lancashire, in Durham, and on the Tyneside. The South Wales company proposes to erect generating stations at coalpits in Neath, Pontypridd and Pontypool, and from these places mains would radiate all over the county of Glamorgan, and the western half of Monmouth. The proposed area of supply covers over 1,000 square miles, and embraces colliery districts, steel and copper works. How little progress has been made in the district regarding the use of electricity may be learned from the fact that only in 16 square miles is there any public supply of electricity. The company stated the charges for electricity would not exceed 2d. as a maximum. Profiting by the experience of the General Power Distribution Company, the promoters of these various schemes carefully avoided any proposals which could be held antagonistic to local authorities. The South Wales Bill provided that the company shall have no exclusive rights; that no retail consumer shall be supplied except by consent of the local authority and by incorporation of the Electric Lighting Acts; that the local authority may, at the end of 42 years, purchase so much of the undertaking as is within their district at a fair market value, with no addition for compulsory purchase, or for goodwill. Seeing that the chief objection of the municipalities against previous schemes was the possibility of the company entering a town, taking up the roads and eventually underselling the corporation, there seemed to be little reason why there should have been much opposition. Yet the feelings of some members of the House of Commons were distinctly against the proposals, and Mr. Galloway, the member for Manchester, speaking on the Lancashire power scheme, said that the whole of the local authorities in the district were averse to the principle of the Bill. There is no doubt a strong feeling amongst municipalities on the subject, but with the powers of the company curtailed in the manner suggested, we fail to see that any harm will accrue to the rights of municipal authorities. Local authorities have a clear right to be heard on the matter, but though there has been much agitation both in Manchester and Liverpool on the subject of these Power Bills, we fail to see that either of these towns are likely to be affected. Probably, if municipalities were generally inclined to develop their electrical undertakings in a manner similar to what prevails in these towns, we should not have heard so much of power schemes. But in considering these proposed distribution schemes, one is compelled to look at a district as a whole. Mr. Seton-Karr pointed out that Lancashire contained 13 county boroughs, 18 boroughs, 86 urban districts, and 12 rural districts. Of these local authorities, only 16 had electric works in operation, and supplied electricity only on a small scale, and at high charges. In 91 districts, or something like two-thirds of the area affected by the Bill, no steps had been taken with a view to obtaining powers to carry out such works. This year there was not a single application for a provisional order to erect electric works from Lancashire. On no grounds could it be said that the demands of the promoters are unreasonable; indeed, those responsible for the South Lancashire scheme gave an assurance that they are not asking for any power to distribute electricity in any borough or district except with the consent of the local authority concerned, and that they will agree to any amendment to make this clear. The promoters were also prepared to insert a provision in the Bill to the effect that whether in bulk or otherwise they shall only supply electricity in those boroughs or districts for which provisional orders or other statutory powers have been obtained. These are eminently reasonable propositions, and, having regard to the importance of the scheme, it was extremely satisfactory that the various Power Bills passed the second reading. No doubt we shall hear a good deal of the views of municipalities when the Committee commences its work, but in the interests of the country and of the electrical industry, it is to be hoped that the municipalities will, in some measure, forego their opposition. We think, however, that Parliament is at last convinced of the far-reaching

effects of the schemes, as Mr. Bryce said of all manufacturing countries, we were nearly at the bottom in the matter of electrical supply, and that was an injury to the amount and the cost of production. It also affected the prosperity of all industries connected with electricity, electrical machinery, for instance, having to be imported instead of being manufactured in this country. Distribution of electrical energy on a large scale will do much to minimise this condition of things, and we trust that the Power Bills may become law.

We may reasonably expect that in the hands of Mr. Ritchie and the Committee to which Parliament entrusts the Bill, the clauses will not be too drastically dealt with. Mr. Ritchie intimated that he would only give the measures his support if local authorities had a controlling voice as to the direction in which the Power Company's mains should be laid.

REVIEW.

Electric Power Transmission. By Louis Bell, Ph.D. New York: *Electrical World and Engineering.* Second edition.

The work covers much the same ground as that traversed by Prof. Unwin's "Power Transmission," with considerable additional facts and figures from actual practice, which renders it, in fact, what it professes to be, "a practical treatise for practical men."

The first chapter deals with elementary principles, briefly, concisely, and from up-to-date views, but it seems rather out of place to refer to the Clerk Maxwell and Hertz theories in a practical power transmission discussion. The practical man generally gets through his education and work by dealing with things more tangible than ether and its assumed properties. The practical units are very clearly explained, and the proposal to adopt a larger unit for force, the megadyne, is good, being a unit nearly equal to the weight of a kilogramme.

On the subject of "conditions of power transmission" the author goes into the matters of fuel, water, wind, and other sources of energy, and the different methods whereby their energy may be transmitted. Fuels such as coal, wood, petroleum, and gases naturally and artificially produced, he considers with waterfalls as the only sources of energy worthy of serious consideration.

Water-power, its utilisation, cost and economy, is most fully treated throughout; to those who dream about harnessing the tides, it would be interesting to note that the author puts the matter in an easily understandable manner. He calculates that to get 1,000 H.P. for five hours, 30 million cubic feet of water would require to be stored and handled in a pond 6 feet deep and 120 acres area. Tidal power might be left out of consideration, but it is useful to give actual figures like these, they have a sobering effect on the man with the harnessing proposals. The conditions of water-power generation and transmission are very fully and fairly stated, with an amount of practical information quite unusual.

Pneumatic transmission refers principally to the Popp system in Paris of 2,000 H.P.; it is, with the exception of a few of the electric power plants, the largest power distributing plant in the world. It is interesting to central station engineers on this side to read that on the Edison supply system, New York, there are 10,000 H.P. in motors.

A comparison is made between the various systems of transmission, both as to first cost and maintenance, and the price per unit delivered; the figures given are of American origin, so that gas comes out much higher in cost than it does on this side. Under the same conditions of transmission for the same amount of power delivered, electricity comes out at $38 per H.P. per year, while compressed air gives the power for $43, rope, $49.

Power transmission by continuous current is very well treated. Its limitations are properly made prominent; "nothing short of a revolution in commutator building can render continuous current available for high voltages"—in other words, for long-distance transmission; at the same time, for electric traction and for distributing power among consumers, continuous current has many advantages. These considerations lead to the question of transforming from one current to the other, and using alternating for transmission and transforming to continuous for distribution. The author has given a name to machines designed for converting alternating to continuous current and *vice versâ* which does not seem very appropriate—"current reorganisers." A current has no "organs," like a machine or a body. However, under this heading we find classed, commutators (sometimes called on this side rectifiers), motor dynamos, and rotary transformers.

The difficulties with all these are fully pointed out; also their uses. It is the first work dealing at all fully on this important subject, and we can quite agree with the opinion, that rectifiers, *i.e.*, synchronising commutators, are of no use except for small currents, such as in a series of arc lamps; all attempts at rectifying large currents variable in amount have ended in the scrap heap. The review of the machines for converting from one current to another is very interesting; in American practice they have some experience of them, especially for electric railway work, wherein no alternating motor, single or polyphase, has as yet been successful.

The chapter on prime movers is not of much value, so far as it treats of steam engines there is nothing interesting or new. The turbine for water-power is well treated and illustrated, also turbine governors, and the development of water-powers is especially well thrashed out; the electrical engineer will find much valuable information on these hydraulic subjects; of course, the abundance of water-power in America makes this branch of engineering of much greater importance than it is with us. That promising prime mover, the steam turbine, is not mentioned; this is no doubt due to the author confining his work to machinery he is personally acquainted with. The same may be said about the vortex water turbine, as made in this country; however that may be, this work really supplies the best of information on the whole question of water-power for electrical generation.

The organisation of power stations, the main supply line, and line construction centres of distribution, and high voltage transmission, are all admirably treated, of course from American practice point of view, in which pole lines figure to a large extent. The pole line allows of the use of very high pressures with cheap construction, hence we find in America over 50 transmission plants over 10,000 volts, 11 of them working at 20,000 volts. All American experience of high pressure transmission seems to be with pole lines, and they have been a success up to 20,000 volts. The pole line is not, however, likely to be used to any extent on this side, with high pressures.

The subject of motors is fully and properly dealt with. We may quote one sentence used in summing up the relative advantages of motors of different kinds, "small motors for *low speeds*, and motors without proper starting appliances (and, we might add, stopping appliances) are responsible for most of the difficulties now encountered."

The book is a large one of about 500 pages closely printed, containing a large store of knowledge and experienced information on a subject which is at present engaging many leading engineers in its development.

CORRESPONDENCE.

"The Working of Steam Engines under Variable Conditions."

Your leading article of February 9th on the above text, and Mr. W. H. Booth's comments on Prof. Weighton's paper on "Receiver Drop," which appeared in the same issue, have stimulated me to fulfil my twice repeated promise to write you a letter on a similar subject.

The art of accommodating steam power to a varying load has been practised during the greater part of the nineteenth century with just as much success as was necessary under the special conditions of its several applications.

When electricity as a transmitter of energy in bulk appeared upon the scene, the conditions became more exacting, since they demanded a constant speed under great possible variations of load. These conditions were effectually met, in some cases by good governors, and in other

cases, principally in London, by quick-handed engine drivers.

In the meantime Willans was conducting his experiments on the steam consumption of steam engines, condensing and non-condensing, the results of which he gave to the world in his two classical papers read before the Inst. C.E. in the years 1888 and 1893.

These two papers throw a flood of light on the economic working of steam engines, which has had the effect of putting tens of thousands of pounds into the pockets of undertakers and consumers of electrical energy.

But Willans has left us, and although there are a few engineers on whom his labours have not been lost, yet to the multitude his conclusions are but as idle talk, a memory faded beyond recognition, or distorted into shapes more pernicious than those of simple ignorance.

At this stage the problem of electric traction appears upon the scene; not much of a problem after all, for Willans in theory, and a multitude of engineers in practice, had already not only shown the way but provided the means of effecting a complete solution. An electric lighting engine only differs from an electric traction engine in that it is too good for its work and in that its valves are not usually set to take a considerable overload, but with "traction" this overload comes occasionally and has to be taken, therefore, unless the economy of the engine at average load be seriously reduced, the engine must be fitted with automatic expansion.

The fact is not minimised by the statement (made in Birmingham and constantly quoted) that a certain form of automatic expansion gear gives no better results than "throttle" governing, for the Willans law applies to all throttled engines; therefore in all throttled engines the full lead must be the most economical, and by no possibility can three-quarter or half load be made the most economical. But with automatic expansion, provided it be worthy of the name, the designer can fix the point of greatest ecomony just where he may choose (within wide limits). He may, in fact, so design a "traction" generating set that at its average load the unit shall be generated under conditions of maximum economy, and the engine shall still be capable of dealing effectively with overloads of 25 per cent. above normal full load.

But the ordinary British-made "traction" generators are not so designed, for two very good reasons, which, unfortunately, cannot be explained in two words.

Some years ago Messrs. Willans & Robinson were very much troubled with the vibration caused by their engines. Therefore Captain Sankey set his wits to work (they are real wits, and not colourable imitations), and evolved on scientific principles the three-crank engine. This engine cured the trouble. W. & R. standardised it, and all the other small vertical engine builders immediately copied it, with the result that English high-speed engines (with, I think, one or two exceptions) are all three-crank.

The bearing of this on the present question grows out of the mechanical difficulty of applying automatic expansion to such engines, in consequence of which they are all dribbling down to "throttle" governing, and their makers try to make out that they give good results.

But, *de gustibus non disputandum*, take this case:—

In November I invited tenders for an alternator and engine (condensing) to give an output of 300 KW. and 10 per cent. overload at 130 lbs. pressure, with 28 lbs. of steam per unit at three-quarter load. Here are the results of the tenders:—

		Steam per Hour.		
	I.H.P.	B.H.P.	Unit.	
A.	...	21·5	31 5	Subject to 5 per
B.	19	...	31 2	cent. allowance
C.	18	...	29 5	on test.

Twelve months ago I had no difficulty in purchasing an engine of half the size which, on test, gave a steam consumption of 28 lbs. per KW.-hour at ¾ load, so it appears that in the course of a year we have lost ground to the extent of 10 per cent. merely for the sake of standardisation on wrong lines, and that, too, at a time when a great movement is taking place to make "lighting" and "traction" generators interchangeable.

Happily, the Willans engine can be fitted with automatic expansion, though at the cost of considerable complication; and the very ingenious device, invented, I believe, by Captain Sankey, provides also for throttling at light load, a most important feature, the reasons for which were fully explained by Captain Sankey in his paper on "Throttling and Variable Expansion," read before the Institution of Mechanical Engineers in April, 1895.

As showing how small was the knowledge on this point at that time, I may quote the remarks of Mr. John G. Hudson, one of the leaders in this country of Corliss engine design. Speaking of automatic shaft expansion governors, he said:—

"The objectionable features of these gears are the too constricted port openings at early points of cut-off, and the enormous governor power generally needed to control them efficiently."

But in the body of the paper Captain Sankey had shown that with pure automatic expansion the steam consumption was always higher at light loads than with "throttling" at same loads. Reference to the diagrams accompanying the paper shows this most clearly. We arrive, therefore, at this conclusion—that a perfect engine for variable loads (such as those of electric traction) must throttle its steam at light loads, or in other words, its expansion gear must give "*constricted port openings at early points of cut-off*." I discovered the advantage of this feature of the shaft governor in the course of my experiments with the Universal engine, when, taking the Willans straight line as the basis of comparison, I found that the curve of steam consumption, even with no load, remained below the Willans straight line, instead of rising above, at it ought to have done with pure automatic expansion. (By pure "automatic expansion" I mean the attainment of maximum initial pressure in the cylinder at all loads, great or small, as is very nearly accomplished by Corliss valve gear.)

The shaft governor reduces the travel of the valve at the same time as it reduces the period of steam admission, consequently at light loads the available port area is too small to allow sufficient steam to enter the cylinder to produce maximum pressure; the result is "throttling," which improves the economy and comfortable working of the engine. But the peculiar advantage of the shaft governor entirely disappears when it is used to drive a valve which controls both the admission and the exhaust, for under such circumstances it increases compression (and compression always increases steam consumption), thereby raising the initial pressure up to or above boiler pressure.

We therefore come down to this conclusion, that the most perfect form of expansion gear for a steam engine working with variable load is attained with a shaft governor in combination with a valve controlling only the admission of steam to the cylinder. But in the great majority of modern steam engines employed in the generation of electrical energy, we find at least two cylinders, one high and one low pressure, and some engineers employ one valve to control the admission and exhaust of both cylinders, and seem by their utterances to be living in a state of blissful ignorance as to the reason why their automatic expansion results are no better than those they obtain with "throttling."

I have already dealt with the high pressure cylinder, and have quoted Captain Sankey's paper, which places the facts outside the region of controversy; I have now to turn to the low pressure cylinder, in connection with which the practice of engineers has been extremely diverse and generally wrong.

Those engineers who have desired to pose as ultra scientific, have specified that the automatic expansion gear should control the cut off of the low pressure as well as of the high pressure, others have fixed the cut off arbitrarily, and some have nearly hit the bull's eye.

The true solution of the problem has now been found, as pointed out in your leading article of February 9th, by Prof. Weighton, of the Newcastle College of Science, who has made an exhaustive series of experiments on this subject, and has given us the benefit of them in his paper on "Receiver Drop," which necessarily covers the whole ground, because "receiver drop" is governed by the cut-off in the low-pressure cylinder.

Prof. Weighton's conclusion is most concise, and is as follows:—"An examination of the whole of these results shows that the one and only factor which affects materially the cut-off of maximum economy in any one of the cylinders

following the high-pressure cylinder is the ratio between the cylinder in question and the immediately preceding cylinder."

Taking the ratio of the cylinders R, Prof. Weighton brings out the kernel of his results in this formula—

$$R \times \frac{\text{Best cut off}}{\text{Stroke}} = \frac{R + 6\,6}{6{\cdot}6}$$

The most curious feature of the paper is the absence of any theory to account for the result; probably Prof. Weighton thought that it would be safer to remain under the bomb-proof shelter of his facts than to expose himself to the fire of his critical audience on the open plain of theory. Nevertheless the explanation does not appear very difficult.

It is obvious that the pressure in the receiver must always be less than the terminal pressure in the high pressure cylinder; it follows, therefore, that the capacity of the low pressure cylinder at cut-off must be at least equal to the total volume of the high pressure cylinder, for if it were less than that amount, it would fail to remove as much steam as the high pressure cylinder exhausted, and the receiver pressure would rise above the terminal pressure and form a loop on the diagram.

On the other hand, if the capacity of the low pressure cylinder at cut-off were much greater than the total volume of the high pressure, the pressure in the receiver would fall considerably, producing a serious drop at the toe of the high pressure diagram.

The effect of this in the extended card is to take a large area out of the figure, as is shown in Prof. Weighton's diagram, No. 11. Of course, there are a few people, including the *Engineer*, whose theories will withstand any amount of dynamite in the shape of facts; if their theory demands that the earth should be flat, then it is flat, and will remain flat so long as they live; to them, receiver drop or free expansion is of no moment, because the energy is transformed into heat, and in a heat engine, of course, heat *must* reappear as energy. The trouble is caused by the simple fact that it does *not* always reappear, in spite of the "*must*."

It is all very well to call a steam engine a heat engine, and so it is, theoretically, but in practice it is a pressure engine, and pressure lost cannot be recovered except in an emaciated condition. Theoretically, there should be no drop between the high pressure and the receiver; but a steam engine has internal friction, therefore there must always be sufficient difference of pressure between terminal pressure and exhaust to drive the engine, otherwise some length of the cylinder would exist for no useful purpose, that is to say, it would measure the steam without getting useful effect out of it; consequently, designers of steam engines never try to come nearer to theoretical perfection than a difference of from 3 to 5 lbs. per square inch between terminal pressure and exhaust. The drop to the receiver should be based on the same principle; anything more is unnecessary and uneconomical, the actual drop being, of course, dependent on the size of the cylinder compared with the size of the engine, or, as Prof. Weighton puts it, "the ratio of the low pressure cylinder to the high pressure." As some drop is necessary, it follows that the volume of the steam exhausted from the high pressure will be increased in the receiver, and consequently the capacity of the low pressure at cut-off must be increased beyond the total volume of the high pressure to enable it to measure off this quantity.

It is at this point that Prof. Weighton's experiments come in, the best results being given in the following table :—

1		2		3
Any cylinder capacity / Preceding cylinder capacity.		Best cut off in inches of stroke.		R × Best cut-off / Stroke.
R				
2·195	...	10½	...	1·28
2·195	...	10½	...	1·28
2·196	...	10½	...	1·28
2·195	...	10¾	...	1·31
2·195	...	10¾	...	1·31
2·296	...	10	...	1·275
2·296	...	11	...	1·4
4·86	...	6⅝	...	1·72
5·04	...	6⅝	...	1·85
11·00	...	4⅜	...	2·67

It should be noted, although it is not mentioned in the paper, that column 3 gives the capacity of the low pressure at cut-off in terms of the volume of the high pressure; thus we find that with the ordinary low ratio of electric lighting engines an increase of 30 per cent. gives the best result.

Some years ago, when testing the Dover electric lighting engines prior to the official test by Prof. Kennedy, I obtained results exactly coinciding with those of Prof. Weighton, but the experiments were not so comprehensive; they were, however, sufficiently conclusive to enable me to fix the cut-off in the low pressure of the "Universal" engine.

It is interesting to note how science makes for simplicity; we now know of a certainty that the most perfect engine for variable loads is one in which all the valve motions are constant, except that of the high pressure admission valve which controls the power and speed of the engine, and that the simple automatic shaft governor throttling the steam at light loads, with the same effect as Captain Sankey's combination of automatic expansion gear and throttle valve, gives better results under extremely variable loads than the most expensive and complicated Corliss gear.

There is one other point which is worth consideration; it is very well set out in the following extract from your article of February 9th :—

"Looking at this question from the standpoint of electrical traction or power distribution generally, with the wide variations in load which are found to be so inimical to economy, it would appear that the high pressure cylinders of such engines ought to be made fairly large in order that, by the rule given by Prof. Weighton, their low pressure cylinders may have a late cut-off. Thus a ratio of 3 : 1 would give, practically, a cut-off at one-half the low pressure stroke—a result that has not been far missed as the finding of general experience."

With Corliss valve gear it is a simple matter to fix the low pressure cut-off at half-stroke, or earlier; but with ordinary positive gear difficulties are encountered. In designing the Universal engine I could not obtain the desired low pressure diagram with an earlier cut-off than 55 to 60 per cent., therefore I had to adopt so low a ratio as 2·25 : 1. The result has justified the means, and has shown conclusively for the fortieth time that the steam engine understands itself better than do any of its designers.

John S. Raworth.

February 27th, 1900.

Electrical Engineering in H.M. Navy.

I can furnish "An Electrical Engineer" with a reply to the question he asks in the Electrical Review of 23rd ult., viz., "Why is electrical knowledge so small in our Navy?"

The Admiralty are pursuing the same course, the time-honoured course, which they pursued with the medical and the marine engineering professions, and with the same result.

It took their Lordships something like half a century to discover that the surgeon had ceased to be the barber, or the leech, that he had been at the time of the Restoration; that he was now an educated man, with the best scientific knowledge of his time at his disposal; and so only bad bats joined the Navy, men who wished to get out of England for various causes.

Gradually, under the pressure of not being able to find surgeons enough, their Lordships redressed surgeons' grievances, and gradually, very gradually, the medical profession have taken their proper position and status.

It was the same with engineers. Their Lordships made the engineers, on board men-of-war, a class apart, badly paid, badly messed, and generally looked down upon; and they got what they asked for—not always the cream of the profession.

Gradually—very gradually—their Lordships have been forced, by the same methods, as with surgeons and others, to redress *some* of the engineers' grievances.

A fleet engineer actually ranks now with—and after—a post captain, and wears four golden stripes on his arm, and the fleet engineer of to-day is the chief engineer of 20 years ago. Further, their Lordships, or Her Majesty, have actually bestowed a knighthood on the head of the naval engineering profession.

But, notwithstanding all this, the old feeling still continues to a large extent. The executive officer still looks

upon the engineer officer as of a lower caste, and hence their Lordships do not obtain all the brains they otherwise might.

But with electrical engineering their Lordships have broken their own record.

They have left the profession out altogether. The sole representative of electrical engineering in a man-of-war occupies the proud position of engine room artificer, a chief petty officer, ranking with chief boatswain's mate, chief gunner's mate, &c., and after—very much after—the junior naval cadet.

The electrician at Portsmouth Dockyard, who was stated to have designed the Admiralty dynamo, the Admiralty pattern switchboard, &c., was a few years ago, I understand, a promoted shipwright. Of course all these things will be righted *in time*, but it will probably be a very long time.

A revolution has taken place in the method of propelling ships during the past 40 years, but the change in the *personnel* has not yet followed.

In Blake's time the crew of the ship worked the ship, and only fought in case of necessity. The soldiers were passengers. Gradually as the English navy developed this passed away, though it survived in the sailing master until about 30 years ago. Gradually the fighting element came to take a pride in being able to handle their ships under sail as well to fight them, and naval officers in Nelson's and Hawke's time were as proud of being good seamen as of being good fighters, and it was owing to the splendid seamanship of some of the old sea dogs that their most brilliant victories were gained.

But the seamen of those days were the engineers of those days, and very skilful engineers too. The wind was their physical agent, and the sails their engines.

Now that sails have gone and that the modern man-of-war is one mass of engines, the engineer is the important man, and the sooner the executive learn to take as great a pride in handling the engines as they did the sails in the old time, the better will it be for all in the day of battle.

There was a striking proof of this at Santiago. Cervera nearly escaped because the executive did not know how long it took to get steam up in cold boilers and to couple engines together. No old sea dog would have been caught like that. Minutes would have put every stitch of available canvas on a ship, where hours were required with steam.

Our American cousins, in their usual practical fashion, have grasped the situation at once, and Engineer-in-chief Melville is now a commodore, the second highest rank in the American navy.

The same thing has to come on this side, and it will come no doubt—in the sweet by-and-bye. And after that the Admiralty may think about the possibility of some day providing an electrical branch.

Meanwhile there are many electrical problems to be worked out on board men-of-war, and they require the best knowledge and experience the electrical profession can produce for their solution.

Sydney F. Walker.

Penalties on Contracts.

May I point out that ratepayers will gain nothing in the end by the enforcement of penalties incurred by contractors for non-delivery within a given time, beyond the legitimate hastening of work, so far as it may be practicable.

Any penalty which is really due to bad management on the part of the contracting firm, will be paid by that firm, or its shareholders; but any sum beyond that which is incurred through causes which are unavoidable, and which are common to the whole of the trade, will eventually be paid by the whole of the buyers of that particular kind of apparatus.

Even the ratepayers of the town whose Council succeeds in penalising a contracting firm to a considerable amount, will themselves repay the whole of the penalty, though they may never do any more business with that particular firm, and even if that particular firm should go out of the trade.

There is only one paymaster, the consumer or the ratepayer, for all apparatus used by Corporations in their electrical supply business; and though the payment may be disguised, and may be difficult to trace, it is paid by him or her collectively in the end.

Sydney F. Walker.

Bloomfield Crescent, Bath.

City and South London Railway Extensions.

We notice in your issue of the 2nd inst. that you have a short article on the opening of the extension to Moorgate Street of the City and South London Railway. It may interest you to know that the signals are worked on the principle of Spagnoletti's electrical locking block, by means of which it is impossible for two trains to get on the same section together; and we are now fitting up the Central London Electrical Railway with the same system. The Metropolitan Railway has been working on this system for a number of years; and owing to the success which has been obtained with it, the system is beginning to be adopted by up-to-date railway companies.

We have also carried out the electric lighting of the three new stations, using the 500 volts generated from the company's power house.

J. E. Spagnoletti & Crookes.

March 6th, 1900.

[Reply to N. C. W.—The list of stock sizes of commutator bars to which you refer, was printed in the Electrical Review, Vol. 41, p. 335; correspondence relating to this subject will also be found on pp. 113, 149, 180, and 209, of the same volume.—Eds. Elec. Rev.]

PRESIDENTIAL ADDRESSES.

The average individual, who has to listen to them, will cordially agree with the President of the Manchester Branch of the Institution of Electrical Engineers when he states that presidential addresses are too many, that they should be curtailed, and the time more usefully occupied.

Can it be supposed that engineers are eager to be deluged with reviews of past work, forecasts of future prospects, and dissertations upon things in general, representing the views, not of the profession as a whole, but of individuals?

Many a paper, of small importance in itself, has led to a most valuable and interesting discussion, in which all who are so inclined can take part; but a presidential address is like a sermon, in that, however distasteful the speaker's views may be, one cannot with decency reply thereto on the spot. By all means curtail the address, or—treat it like other papers, and *discuss* it!

In this connection we wish to draw attention to the time wasted by the reading of papers in general. Surely it would be far better for members to study these at their leisure, prepare their remarks beforehand, and devote the whole time they are assembled together to the discussion—which, unlike the reading of the paper, *cannot* be carried out elsewhere. The paper might be read in abstract by the author, as an introduction to the debate, and, of course, exceptions must be made where numerous experiments illlustrate the subject; but we think that the majority of members, especially those who come up from the country to attend meetings, would heartily appreciate this course of procedure—which, indeed, we believe is already in force at some places.

Returning to Dr. Edward Hopkinson's address, we note that in his view there is no evidence that work is done more cheaply in America than in this country. But it is admitted that the American workman accomplishes somewhat more in a given time, and is in receipt of higher wages; the net result is *not* the same, for it follows at once that capital charges bear a smaller proportion to the total cost of production. The conditions in a factory are analogous to those in an electricity works in this respect; the higher the load factor of the plant, the less are the fixed charges in proportion to the total.

If American workmen worked shorter hours than English workmen, this gain would be neutralised; the President went on to ascribe the larger output of the former chiefly to their higher culture and "wider mental horizon," and stated that as workmen were better educated they worked shorter hours. The fact remains, however, that American workmen, in spite of their alleged refinement, work far longer hours than the English. This not only upsets the President's arguments *re* greater refinement—greater output—shorter hours, but strengthens the above conclusion regarding the "load factor" as the cause of cheapness.

Due emphasis is laid on the necessity of standardisation and of the use of automatic machine tools; the former, it is suggested, might be brought about by impressing its importance upon technical students during their college career, while the adoption of the metric system might be hastened in the same way. The suggestion may be not without value; but the effects of this procedure would certainly not be apparent until the said students attained to positions of responsibility, which would delay the desired consummation for a good many years.

The address winds up with a proposition which can only be regarded as utterly impracticable and undesirable; to wit, that all British engineers, civil, mechanical, naval, or electrical, and (we presume) sanitary and mining, should be combined in one great Institution, with a great central house and library, and similar branches in the chief centres of industry. That such a suggestion should be put forward in these days of specialisation, when no man can hope to keep in touch with more than a very limited range of subjects in his own profession, is a matter for astonishment. What possible advantage could the various branches of the engineering profession derive from the combination? There would have to be as many separate papers, as many separate meeting-rooms, journals, organisations, &c., as at present, for it would be absurd to treat the whole body of members without discrimination; nor do we believe that the burden of subscriptions would be lessened. To distribute the *Proceedings* of the whole Institution to each member would be sheer waste of time and money; but few, even now, can afford the time to thoroughly study the *Proceedings* of their own special branches, and the proportion of members who took an interest in all the *Proceedings* would be infinitesimal. Truly, we cannot but think that the idea is beyond the region of practical possibility.

FIRE AT THE MAIDEN LANE ELECTRICITY WORKS.

From the reports which have obtained circulation both in the Press and out of it, it might have been imagined that the fire which occurred at the Maiden Lane station of the Charing Cross and Strand Electricity Supply Corporation on Saturday last had left the works practically gutted, causing the maximum of inconvenience to consumers; an inquiry on the spot, however, showed that the true state of things was very different from what we had at first supposed. That a good deal of damage to machinery and so forth has been done, and a certain temporary inconvenience has been caused to consumers is quite true, but thanks to the splendid way in which Mr. W. H. Patchell, the corporation's engineer, and Mr. Wilmot Seale, the secretary, have directed the many operations necessary for maintaining the supply, in spite of destroyed and disabled plant and cables, there is not likely to be much grumbling on the part of the consumer.

The Charing Cross Company has lately been running the Maiden Lane station for 24 hours a day, the Lambeth station rendering service as it was needed; but since the conflagration this has been reversed, and the Lambeth station has been running continuously. At Lambeth there is a plant capacity of 6,000 kw. (shortly to be increased to 9,000 kw.), and this has been of great assistance in tiding over the mishap period: the large sub-station at Short's Gardens, which receives current from Lambeth at 1,000 volts, has 1½ 100-kw. Siemens motor generators running on one floor. When this very large sub-station is completed, probably in the course of a few months, there will be 16 more 100-kw. motor generators in position on the floor above the 12 now running, and a 400-kw. Tudor battery on a still higher floor.

The rapidity with which the Charing Cross Company has been extending its stations and putting in new plant has been an untold blessing to Mr. Patchell in this emergency, as it has enabled a supply to be given to all consumers when some at least might reasonably have expected to have to do without for a few days.

Steady pressure has characterised the supply of the Charing Cross Company for a long time past, which cannot be said of some other London supply companies, as we all know; therefore its consumers have been inclined to grant indulgence now that the pressure is somewhat below the normal at full-load times. The company naturally prides itself upon the reputation for maintaining supply at the proper voltage, but when it is stated that about the only inconvenience that customers suffered from the Maiden Lane fire was a supply at reduced pressure—96 volts was the recorded pressure on Monday—it will be seen that the company's engineer and secretary are to be congratulated upon the smart way in which they devised means for temporarily overcoming the difficulty in which they were placed.

As to the cause of the fire itself we are given to understand that there is not one iota of evidence that the fire was an electrical one. On Friday night the Maiden Lane station was running as usual. Lambeth station was shut down at the ordinary time, so that the high tension supply was altogether "off." The night shift engineer noticed nothing abnormal in the boiler room; coming up later over the top of the cables smoke was smelt and seen issuing from the basement. Just here the cables come in from the Strand, and are led up in a brickwork protection through the floor to the back of the switchboard in the engine room. The resident foreman examined the steam dynamos, and there was no overloading, everything was running perfectly smoothly; but immediately thereafter flame was bursting out brightly from the basement referred to. Those then at work shut down the machines and retired in haste for personal safety. The main switchboard cables running through this basement formed an excellent flue for the hot gases, and they burned with remarkable fierceness. They were vulcanised bitite, and lead-covered and armoured jute cables. There was not a vestige of insulation left anywhere, the wire being perfectly clean. The fire summons was given at about 1.50 a.m., and when Mr. Patchell, whose residence is in communication with the place by telephone, arrived an hour or two later on his bicycle, the network was immediately disconnected and Lambeth station set to work, with the result that current was on again by 9 o'clock in the morning.

Everything radiating from Maiden Lane had been short circuited, insulation being burnt off. Efforts were made to establish temporary connections, and a supply of cables which happened to be in stock came in very handy for this purpose.

Thirteen 110-kw. motor generators and three 110-kw. steam dynamos were damaged by the fire, and of these four of the former and two of the latter were, after some amount of coaxing, got to run. With the utmost urgency some of the machines were "dried out," and, in fact, were supplying current by Saturday night, when all the principal buildings connected to the corporation's system were lighted. From that time new machines have been adding, and by the time these remarks appear in print everything will be practically in normal working order with temporary connections as indicated.

Those who are familiar with the work of supplying current in the metropolitan districts will at once appreciate the difficult position in which the company has been placed by this unfortunate occurrence, and what a great deal of extra work and worry has fallen upon Mr. Patchell and his staff. It must have been a source of great satisfaction to the company's board and shareholders to be so admirably brought through a trying time without sacrificing in any way that excellent reputation which the Company has secured among consumers throughout its district. The forbearance which consumers have shown during the past few days must be regarded as an additional tribute to the excellent relations which exist between the Charing Cross Company and its customers.

The company's official account of the fire which has been placed in circulation states:—

"Considerable damage was done to the works, which, however, is substantially covered by insurance. The only portion of our districts which was prejudicially affected was the southern district, and that in effect only for a few hours. The board met immediately and gave instructions to the staff to use every effort to prevent, as far as possible, any stoppage of the supply to our customers. The work was so satisfactorily performed that on the same afternoon we were able to supply the theatres and several other large buildings, and by to-night we are practically ready to take up the usual work of the company. . . . . The board wish to testify to the untiring energy of the secretary, Mr. Seale, and the engineer, Mr. Patchell, and the other members of the staff, in this emergency."

LEGAL.

Hawkes *v.* Leyton Urban District Council.

The case of Hawkes *v.* The Leyton Urban District Council was heard by Mr. Justice Buckley, in the Chancery Division last week, it being an action by the plaintiff, Elijah Hawkes, for an injunction to restrain the defendants, their servants, and agents, from carrying on their electric supply works at Leytonstone, so as to cause a nuisance by noise and vibration to the plaintiff as owner and occupier of premises in the Cathall Road, Leytonstone. There was an alternative claim for damages. The facts sufficiently appear from the judgment.

Mr. Justice Buckley said that the plaintiff was the owner of a house in which he resided in the Cathall Road, Leytonstone, and the action was brought by him for an injunction to restrain the defendants, the Urban District Council of Leyton from carrying on certain electric supply works within the district, so as to cause a nuisance by noise or vibration to the plaintiff. The plaintiff gave evidence as to the actual existence of vibration and noise to a very considerable extent, and the evidence satisfied his Lordship that there did result in the operation of the defendants' works such an amount of noise and vibration as amounted in law to a nuisance. The defendants admitted that at the date of the issue of the writ down to July last the works were so carried on that there was a nuisance created, but they insisted that the alteration which had been made at the works had the result of remedying it altogether. The plaintiff, however, gave evidence that the nuisance had gone on down to the present time. Various other witnesses from the neighbourhood also spoke as to the existence of noise and vibration caused by the defendants' works. When defendants' counsel got up to open their case, his Lordship suggested that he wanted to hear evidence that the noise and vibration did not occur. Their counsel, however, indicated that he was going to call scientific evidence to prove that the circumstances were such that it could not occur. In

the first place, they called Mr. Dugald Clark, who went down to the *locus in quo* on February 24th. That gentleman said he applied various tests, and took with him instruments to detect horizontal and vertical vibration. Mr. Clark said he was satisfied there were no horizontal or vertical vibrations. He also said that he applied other tests by putting his ear to the floor, and so on, and the result was that he did not hear any noise. The witness also said that he had applied no tests at all as to the existence of aerial vibrations. The result of his evidence, therefore, was that the defendants' plant could be so run that a person could not detect horizontal or vertical vibration. That was the result of the whole of his evidence. Mr. Clark left the place about 9.30 p.m., and about 3 a.m. there was again extensive noise and vibration. The defendants had not met that at all, and had called no one to show what was the state of things at the time, and had done nothing to show his Lordship that the plaintiff's story as to that was not credible. His Lordship then referred in some detail to the evidence given by some of the defendants' engineers, and said that he had come to the conclusion that the gas engines in the defendants' works required very careful watching to prevent them becoming a nuisance. Steam engines were very much better than gas engines, but the defendants said that to replace the gas engines by steam engines would be very expensive. It appeared that the demand for the electric light in the neighbourhood was large. The extension of and additions to the defendants' works had been made because a larger supply of electricity was required than the undertaking could furnish. The defendants were now working close to their full capacity. They were not going to stop their gas engines, but had ordered more steam engines. The state of things therefore was that the defendants would continue to use the gas engines, which would be supplemented by steam engines, for which additional buildings were being erected. The plaintiff having proved that a nuisance was caused by noise and vibration, were not the defendants, in the circumstances, threatening to continue such a state of things? His Lordship thought they were. It was part of the defendants' case that their works could be carried on so as not to create a nuisance. When Mr. Dugald Clark went down, care was taken that the plant was run carefully, and as long as Mr. Clark was there there was nothing wrong at all. Soon after he went away, however, there were explosions. It appeared to him that he was bound to grant an injunction in the terms of the writ to restrain the defendants from so carrying on their works so as to cause a nuisance to the plaintiff by noise or vibration. He accordingly granted a perpetual injunction in those terms, and ordered the defendants to pay the costs of the action.

His Lordship suspended the operation of the injunction till April 9th to enable the defendants to consider what could be done to remedy the nuisance, the defendants undertaking in the meantime to stop the "back firing" in the exhaust pipes and explosions as far as possible.

National Telephone Company, Limited, *v.* Evers.

On Friday last this action was entered for trial before Mr. Justice Grantham and a Queen's Bench special jury.

Mr. J. Compton Smith appeared for the plaintiff company, and Mr. F. Dodd for the defendant.

Mr. Compton Smith said his Lordship would not be troubled with the trial, as terms had been agreed upon between the parties, though it would not be necessary to read them in open Court. He asked his Lordship to make an order that £50 paid into Court should be handed over to the plaintiffs, and that proceedings should be stayed.

Order accordingly.

BUSINESS NOTES.

The Copper Market.—Messrs. H. R. Merton & Co.'s circular relating to copper in February shows that while stocks have increased by 1,655 tons, prices have advanced from £71 5s. on the first of the month, to £74 15s. at its close, although there has been a falling away of 2s. 6d. per ton since the 15th of the month. Deliveries during February have totalled 23,272 tons, a total that has been exceeded only once since April, 1898. This high total is chiefly due to larger shipments from North America, the total from this quarter of the world being 13,027 tons as compared with an average of 9,800 tons for the preceding 12 months. The shipments from "other countries" only totalled 3,141 tons, and are below the average. Deliveries in February have reached a total of 21,117 tons, and in addition 500 tons have been shipped to New York. The total deliveries are therefore 21,617 tons, and stocks have increased from 21,327 tons on January 31st to 22,982 tons on February 28th.

High Tension Switches and Fuses.—Messrs. Verity, Limited, write to us from Aston as follows:—"Concerning the recent death of one of the Blackheath and District Electric Lighting Company's engineers reported in your paper, we note from evidence given at the inquest that deceased met his death by coming in contact with one of the high tension switches, the live parts of which were exposed. We consider it useful to mention, for the benefit of all concerned, that we have developed a system of high tension switches and fuses (Verity & Steele's patents) for use in central and sub-stations, which offer absolute protection and safety under all conditions of working; and that by their use a recurrence of the above sad accident would be well nigh impossible."

Electrical Wares Exported.

Week ending Feb. 28th, 1889.		Week ending Feb. 27th, 1900.	
Amsterdam	Value £100	Adelaide	Value £86
Auckland	686	Alexandria. Teleg. cable	271
Bombay	55	Amsterdam	325
Boulogne	61	Bangkok	140
Buenos Ayres. Teleg. mat.	321	Boca. Teleg. mat.	231
Calcutta	1,186	Bombay	115
Cape Town	828	Bremerhaven. Teleg. cable	8,580
Christiania	90	Buenos Ayres. Teleg. mat.	20
Colombo	185	Calcutta	1,507
Delagoa Bay. Teleg. mat.	338	" Teleg. wire	233
Durban	62	Colombo	176
" Teleg. mat.	717	" Teleg. mat.	66
East London	77	Copenhagen. Teleg. cable	285
Fremantle	297	Durban	24
Genoa	125	East London	11
Gothenburg	21	Fremantle	1,164
Hamburg	300	" Teleg. mat.	272
Hobart	728	Gibraltar. Teleg. apparatus.	20
Hong Kong	13	Gothenburg. Teleg. wire	227
Liban	60	Haiphong	172
Malaga	45	Halifax	10
Malta	60	Hamburg	66
Montreal	61	" Teleg. mat.	300
Ostend	119	Hong Kong	213
Penang	13	Launceston	60
Perth	50	Malta	32
Port Elizabeth	40	Melbourne	258
Rotterdam. Teleg. cable	27	Mogador	44
St. Petersburg	11	North Atlantic. Teleg. cable.	1,380
" Teleg. mat.	323	Ostend	112
Stockholm. Teleg. mat.	130	Otago	126
Sydney	2,565	Paris	89
" Teleg. mat.	266	Pernambuco. Teleg. cable	3,000
Vera Cruz	13	Port Chalmers. Telephones	42
Wellington	657	Rio Janeiro	209
" Teleg. mat.	2,090	Santos	80
Yokohama	475	Shanghai	255
		" Teleg. mat.	122
		Singapore. Teleg. mat.	180
		Sydney	525
		Trinidad	24
		Wellington. Teleg. mat.	431
Total	£13,177	Total	£21,456

Foreign Goods Transhipped.

Malaga. Elec. light apprs. Value £280 | Gothenburg. Tph. apprs. Value £425

Electrical Wares Exported.

Week ending Mar. 7th, 1899.		Week ending Mar. 6th, 1900.	
Adelaide	Value £38	Adelaide	Value £264
Alexandria	18	Amsterdam	60
Amsterdam	142	Auckland	20
Boulogne	42	Azores. Teleg. mat.	2,134
Bremen. Teleg. mat.	90	Bombay	86
Buenos Ayres	763	" Teleg. wire	105
Cadiz	10	Buenos Ayres. Teleg. mat.	193
Calcutta	201	" Teleg. wire	186
Christchurch	13	"	200
Christiania	25	Calcutta	801
Colombo	41	Christiania. Teleg. wire	21
Copenhagen	168	Colombo	313
Delagoa Bay	206	Copenhagen. Teleg. cable	259
Durban. Teleg. mat.	117	" Teleg. wire	29
East London	1,099	Demerara	52
Gibraltar	259	Durban	1,231
" Teleg. instruments	1,530	" Teleg. mat.	763
Gothenburg	70	" Teleph. mat.	161
Hamburg	140	East London	29
Hobart	137	Ghent	83
Kobe	2,342	Gibraltar	20
Launceston	98	Gothenburg. Teleg. wire	110
Lyttleton	25	Halifax	25
Melbourne	261	" Teleg. cable	111,300
" Teleg. mat.	946	Hamburg	10
Penang	20	Kobe. Teleph. cable	737
Perth	178	Mauritius	42
Port Chalmers	31	Melbourne	270
Port Elizabeth	1,517	" Elec. cable	450
" Teleg. mat.	773	" Teleph. cable	335
Port Said	137	Ostend	107
Rio de Janeiro. Teleg mat.	331	Port Elizabeth. Teleg. mat.	1,277
Rotterdam. Teleg. mat.	36	Rio Janeiro	64
Santos. Teleg. mat.	118	Rotterdam. Teleg. mat.	300
Shanghai	469	Saigon	696
Singapore. Teleg. mat.	161	Singapore	298
Sydney	286	Sydney	1,698
Wellington	148	Valparaiso	60
" Teleg. mat.	298	Wellington	614
		" Teleg. mat.	347
		Yokohama	560
Total	£13,219	Total	£125,753

Foreign Goods Transhipped.

Durban. Teleg. mat.	Value £29	Malaga. Elec. light mat.	Value £86
Rockhampton. Electric light apparatus	71	Rio Janeiro. Elecl. mat.	57
		Trinidad. Teleph. mat.	65
Total	£100	Total	£208

Bankruptcy Proceedings.—A receiving order has been made against Frederick Metcalfe, electrical engineer, White Horse Street, Boar Lane, Leeds, on his own petition.

The first meeting of creditors and public examination of A. R. Earle, electrical engineer, Theatre Street, Norwich, will be held at Norwich on March 9th and 21st respectively.

At a sitting of the London Bankruptcy Court, held last week before Mr. Registrar Hope, John Haddon Douglas-Willan, 16, St. Helen's Place, E.C., applied to pass his public examination upon accounts showing gross liabilities £12,170 18s. 6d., and assets £67,305 10s. 8d., representing (with the exception of £40), by the debtor's estimated value of his interest in the Bowen and the Bowen-Willan electric lamp patents. Under examination by the Official Receiver, the debtor said that about December, 1895, he purchased for £450 the inventor's interest in the "Stein electric lamp," and

was joined by another person to whom he gave a half-share in consideration of services rendered, and to be rendered in connection with the development of the lamp. They shortly afterwards sold for £1,000 a fourth share in the lamp, each partner taking £250, the balance being applied towards expenses. In or about February, 1896, he and his partner entered into an agreement with the inventor of the "Bowen electric lamp," under which they received two one-third shares in the invention in consideration of their agreeing to provide the necessary funds for taking out and developing the patents. They endeavoured to develop the "Stein" and the "Bowen" lamps with the intention of disposing of them to a company, but in 1898, after having expended about £3,136 on the "Stein" lamp they abandoned it in consequence of the "Bowen" lamp having superseded it. About 12 months ago, having expended some £2,640 on the "Bowen" lamp, and being unable to pay to the inventor the wages due under the agreement between them, witness's partner withdrew, leaving him to take over the liabilities and assets. He thereupon entered into a fresh agreement with the inventor, under which he (debtor) was to receive 20 per cent. of the net profits derived from the sale or working of the patents. He would not admit that he was insolvent, and explained his appearance at the Court, by pressure on the part of creditors. He had a 14 per cent. interest in the patent, which he considered was worth £70,000, but which he was unable to immediately realise. The examination was ordered to be concluded.

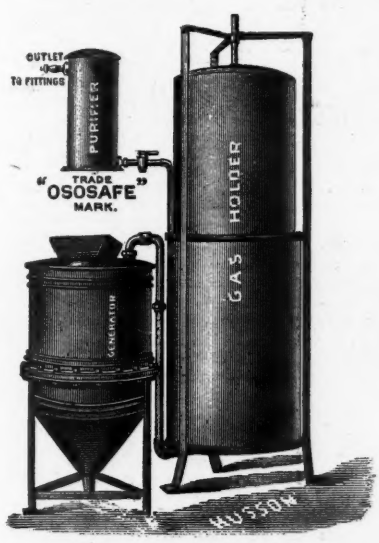
The first meeting and public examination of Frederick Metcalfe, electrical engineer, Leeds, are arranged for March 14th and 27th respectively, at Leeds.

Application for an order of discharge has been made on behalf of E. Max. Winter, electrical engineer, Amberley House, Norfolk Street, Strand, but discharge has been suspended for two years from February 6th, 1900.

Liquidations.—Creditors of Browett, Lindley & Co., Limited, (old company, in liquidation) are to send particulars of debts, &c., to A. Shuttleworth, liquidator, Ducby Chambers, Clarence Street, Manchester, by April 6th.

The Woodlands Electric Company, Limited, is winding up voluntarily. Mr. F. J. Armstrong, 59, Drury Buildings, Water Street, Liverpool, is liquidator.

Acetylene Generators.—We illustrate below Husson's safety acetylene generator, the British and Colonial patent rights in which have been acquired by the Husson's Safety Acetylene Syndicate, of Victoria Street, S.W. We understand that the syndicate is entering into contracts for the sale and installation of plants for lighting towns, villages, railways, hotels, houses, &c. The Husson plant is a Swiss invention, and is said to have made very great progress in



Switzerland. At the recent National Exhibition at Thun, Switzerland, it obtained the highest award. It is claimed that the apparatus whilst most safe, reliable and efficient in working, is so simple that a child can charge it, and, having no working mechanism, it cannot get out of order. The syndicate is establishing depôts and agencies in the principal districts of the United Kingdom.

Books Received.—"Institution of Junior Engineers' Record of Transactions." Published by the Institution. 10s. 6d.

"Hydraulic Power Engineering," by G. Croydon Marks. London: Crosby Lockwood & Son. 9s. net.

Catalogues, &c.—From Messrs. W. T. Glover & Co., Limited, there comes to hand a copy of a new catalogue which has been recently issued to the trade. A convenient thumb index divides the various sections in which the firm's manufactures in wires and cables for electric lighting and power purposes are particularised. The booklet opens with some details of conductors, showing dimensions, capacity, resistance, and weight of conductors, these tables having been revised since the last edition; they are followed with exhaustive table matter relating to vulcanised wires and cables, twin lead-covered and concentric cables, B.O.T. armoured cables, Diatrine cables for town lighting, pure rubber cables, aerial and dynamo cables, concentric wiring, flexibles, &c. Some conversion tables, an extract from the Institution of Electrical Engineers' rules, and other things, complete this very handy and useful catalogue of 63 pp.

Pamphlet No. 54 of the B.T.H. Co. is devoted to electric traction, and gives some general notes and illustrations regarding the Bristol, Dublin, Middlesbrough, Dover and Ceylon systems. A table is given of electric tramways and railways in the United Kingdom either equipped or equipping by the B.T.H Co.

Mr. C. R. Heap, of Victoria Street, sends us copies of new bulletins which have been issued by the C. & C. Electric Company, of Garwood, N.J., for whom he is the sole importer for the United Kingdom. One of the pamphlets describes the C. & C. four-pole open and closed motors and dynamos, the general construction of which is very similar to the C. & C. "Ironclad" machines, but the brush gear and interior of motor are made practically as accessible as in an unprotected machine. The other pamphlet deals with some "special types."

A neatly arranged pamphlet comes to hand from Mr. F. H. Headley, of St. Austell, dealing with the uses of electricity for country house purposes, such as lighting, pumping, lifts, and so on.

We have received from Messrs. R. W. Blackwell & Co. a catalogue (No. 24) in which their electric light, traction, and power apparatus, and supplies are described. Some street views are given showing trolley standard and wire work carried out by the firm. Girder and tee rails, and special work receive first mention along with the "third rail" insulator, and the Falk cast-welded rail joints; Chicago and other types of rail bonds; motor trucks (with photos of cars supplied on several English lines), air brakes, trolleys, poles, line material, lightning arresters, switches, circuit breakers, switchboard instruments, incandescent lamps, transformers, Reynolds-Corliss engines (Allis), McIntosh & Seymour, Chandler-Taylor engines, separators, Allis feed-heaters, condensing and coal-handling plant, and numerous accessories. The mere mention of the above items serves to show what a vast ground is covered in the catalogue, which is nicely printed, very fully illustrated, and well bound. It should be of service to authorities having the electrical equipment of tramways in prospect.

The St. Helen's Cable Company, Limited, send us price lists of their pure and vulcanised rubber and paper insulated cables, and a sample of their new "N" jointing tape, which is intended to replace pure rubber tape for covering joints in vulcanised rubber or paper insulated cables. It is claimed that this tape is both waterproof and indestructible, while it has no effect on either plain or tinned copper. The company is also introducing a new kind of rubber floor covering for high pressure work, consisting of alternate layers of rubber and "Impregnable" paper.

Messrs. G. W. Matthew & Co., electrical engineers, of Cardiff, send us a perpetual desk or hanging calendar, consisting of a clock face with movable hands.

From the Ward-Leonard Electric Company, of America, we have received a copy of their new catalogue, No. 1900, which contains illustrated descriptions of a large number of types and sizes of rheostats for both starting and controlling service. The catalogue covers nearly 1,000 standard stock rheostats and circuit breakers. The makers say that they have sold during the past three years over 100,000 rheostats and circuit breakers. We are given to understand that with the introduction of this catalogue the prices on the well-known type of Carpenter enamel field rheostats have been reduced from 25 per cent. to 50 per cent. (depending upon the size and type) over prices prevailing, for equivalent apparatus, six months ago, while on most sizes the number of steps has been increased for the same size of instrument.

The Société Française des Accumulateurs "Phénix" send us a price list of their storage cells, portable and stationary, for which a large specific storage capacity and great durability are claimed.

The Shropshire Iron Company, Limited, has issued a list (February 1st) of its iron and steel manufactures.

Messrs. Holden & Brooke, Limited, of West Gorton, have issued a small list of their pattern A steam separators or dryers which have now been adopted for working pressures up to 300 lbs. per square inch.

Messrs. T. Parker, Limited, send us one of their Pocket Lists (third edition, January, 1900) in which details and illustrations are given of their continuous current dynamos, motors, contractors' electrical locomotives, switches, resistances, &c.

Pamphlet No. 55 of the British Thomson-Houston Company describes and shows the G.E. 800 motor; No. 42 details and illustrates the series parallel magnetic blow-out controllers (forms K and L) for electric cars and locomotives. Both lists are very well printed, and they will form useful additions to the company's other lists already issued.

Messrs. W. H. Allen, Son & Co. send us a copy of their most recent price sheet of two-crank enclosed compound engines, with a useful table of speeds and horse-powers.

The Improved Electric Glow Lamp Company, Limited, have issued a small four-page list of lamps illustrating some additions to their stock, including opaline, side-silvered and pear shape lamps.

Messrs. Everett & Co., of Charterhouse Square, have issued a well arranged pamphlet giving prices, reference numbers, &c., of their physical and scientific apparatus including various types of galvanometers, shunts, resistance coils, Wheatstone bridges, test sets, rheostats, electrometers, keys and switches and various other lines in electrical and other apparatus.

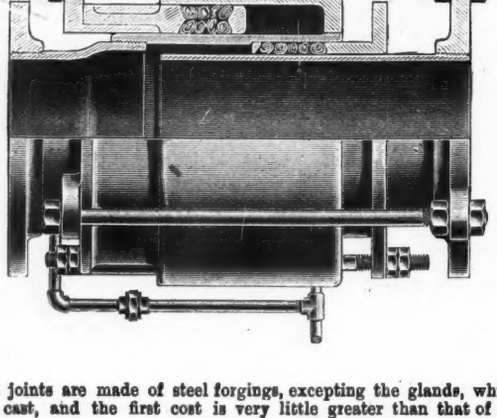
The Electric Power Bills.—In the House of Commons on Tuesday Lord Balcarres asked the President of the Board of Trade whether, in order to obtain a tribunal appointed on non-party

lines, he was prepared to recommend that the Committee to whom the Electric Energy Bills were to be entrusted should be exclusively nominated by the Committee of Selection.— Mr. Ritchie replied in the affirmative. He thought that the House would do wisely if it resolved that the Committee should be nominated as the hon. member suggested.

Electric Cranes.—At a meeting of the Southampton Harbour Board recently, it transpired that a letter had been received from the Clyde Shipping Company complaining of serious delays to their steamers lately owing to the current being cut off from the cranes without notice. The Corporation electrical engineer had written that when alterations were made, enabling the cranes to be supplied from the tramway system, a much more steady and satisfactory supply would be given. The wharfinger recommended that another crane should be provided to be available for any berth on the quay. During 1899 there were discharged with the electric cranes 62 steamers with miscellaneous cargoes, and between 20 and 30 sailing vessels, in addition to the Clyde Company's steamers and some of the Cork Company's, this being, the Works Committee pointed out, entirely a new trade since the introduction of electric power at the quay. Already this year nine steamers and seven sailing vessels had been discharged, and there was every probability of the increased traffic being maintained. This matter had been referred to a sub-committee. It was resolved to send a letter to the Electrical Committee of the Corporation with reference to the irregularity in the supply of current to the cranes.

Electrical Dredges.—The *Sydney Bulletin* says that Mr. J. A. Wallace, the pioneer of the gold dredging industry in Australia, holds a long stretch of the Sandy Creek, near Yackandandah, and intends installing a very large electrical plant to operate several dredges. The Austral Otis Engineering Company, of South Melbourne, has an order to supply high-class compound condensing engines with Corliss valve gear of 400-H.P., together with boilers and fittings, to operate the first section of the plant. A duplicate plant to this will be installed later, and will work three electric dredges on a stretch of about two miles of the creek. The capacity of each dredge will be about 150 cubic yards per hour.

Expansion Joint.—Messrs. Brown & Co., 49, Deansgate, Manchester, send us particulars of their balanced expansion joint, which should be a useful fitting to steam users in general, and central stations in particular. It is designed to prevent the forcing apart of joints in steam pipes, and the illustration will show its action. The joint is surrounded by an annular chamber of cross-section equal to the steam pipe, in which a tightly packed ring acts as a piston. Steam is admitted to this chamber by means of a bye-pass. The tendency would be to force out the piston, and so draw the ends of the pipe closer together, but as the steam in the pipe and in the chamber is of the same total pressure, each force neutralises the other, and the joint is rendered secure under all ordinary circumstances.



The joints are made of steel forgings, excepting the glands, which are cast, and the first cost is very little greater than that of an ordinary joint.

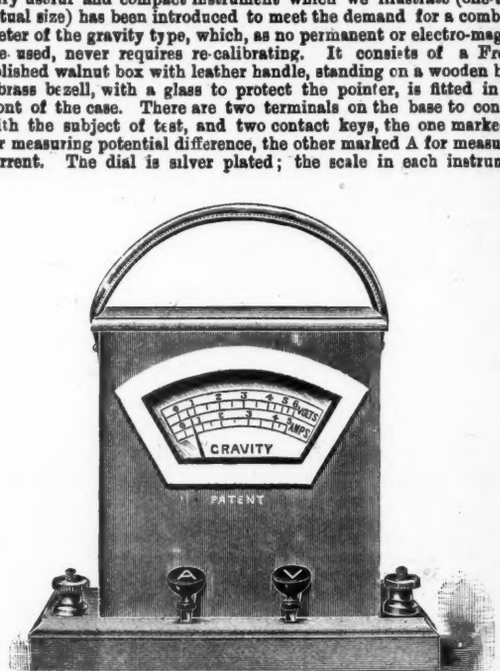
Fire.—There was a slight fire at the works of the London Electric Supply Corporation, Limited, in Juxon Street, Lambeth, S.E., on the night of the 4th inst. through the failure of a converter in the storage room.

Football.—The second annual football match between the Blackpool Electric Football Club and a team representing the B.I.W. Company, Prescot, took place last Saturday at Blackpool, and resulted, after a very fast and evenly contested game, in a win for the home team by 3 goals to 1. The teams were afterwards entertained to dinner by the committee of the home club.

For Sale. — The charging station, machinery, plant, licences, cabs and premises in Juxon Street, Lambeth, of the London Electrical Cab Company, Limited, are offered for sale by tender by order of Mr. Justice Byrne. See our "Official Notices" this week for particulars.

Gas v. Electricity.—At the annual meeting of the Manchester District Institution of Gas Engineers, Mr. T. N. Ritson, Kendal, delivered his inaugural address, in which he stated that there were in the United Kingdom to-day 661 authorised gas undertakings, 222 owned by local authorities, and 439 by private companies, in addition to over 1,000 non-statutory undertakings. The capital employed in the statutory undertakings amounts to £82,109,752. Notwithstanding competition from oil, electricity, and the newly-discovered acetylene, the demand for gas was steadily increasing, and gas stocks, he said, stood higher to-day than at any other period in the history of gas manufacture. That electricity was a keen competitor could not be denied, but statistics proved that gas and electricity could and did flourish side by side. There could be no doubt that the new illuminant had aroused gas authorities to a sense of their duty, and the results of the spirit of enterprise thus brought about had been an increased output of gas and increased profits, while the public had benefited by cheaper gas and improved methods of lighting, both privately and publicly. Notwithstanding the enormous development of the supply of electricity, no fewer than 77 gas undertakings had been purchased by local authorities from private gas companies since the year 1882, and several applications for transfers of works were to be considered during the present session of Parliament.

Gravity Combined Ammeter and Voltmeter.— The very useful and compact instrument which we illustrate (one-third actual size) has been introduced to meet the demand for a combined meter of the gravity type, which, as no permanent or electro-magnets are used, never requires re-calibrating. It consists of a French polished walnut box with leather handle, standing on a wooden base; a brass bezell, with a glass to protect the pointer, is fitted in the front of the case. There are two terminals on the base to connect with the subject of test, and two contact keys, the one marked V for measuring potential difference, the other marked A for measuring current. The dial is silver plated; the scale in each instrument



is marked by hand during calibration and afterwards engraved, this method preventing errors caused by the use of printed scales or dials. This is claimed to be of great importance to users. The scale being unusually large, the readings can be easily seen; a novel feature is the double scale, the top part of which is used for volts, and the bottom for amperes. No calculations are necessary, as the readings are directly given. The instrument should be found very useful for many purposes, which will at once suggest themselves, and has the advantage, as compared with an ordinary "detector," that its indications are in terms of definite units, instead of in meaningless "degrees." The patentee and maker of the instrument is Mr. W. R. Morris, Faraday Works, Henrietta Street, Birmingham.

Hornsby Boilers.—The Crystal Palace District Electric Supply Company, Limited, of Sydenham, have put in a pair of "Hornsby" water-tube boilers, the satisfactory working of which has resulted in an order for two pairs more being placed with Messrs. Hornsby.

The Institution of Junior Engineers.—Last Saturday, March 3rd, a large number of members visited Messrs. Maudslay, Sons & Field's Belleville Boiler Works, at East Greenwich. They saw all the machinery for the preparation of the different parts forming the elements; the method of erection was explained, and the special features of construction pointed out. The Cowper-Coles apparatus for galvanising the tubes, &c., was also seen, and the system of working it described.

The Question of Municipal Trading.—A question was asked in Parliament this week *re* municipal trading, by Mr. Kimber. He asked whether, pending the appointment of the Municipal Trading Committee recently promised, the Government would oppose, or cause to be deferred, any Bills or clauses in Bills promoted by municipal authorities seeking powers to trade or manufacture. Mr. Balfour, in reply, said that no general principle such as Mr. Kimber suggested could be adopted. Each case must be considered on its merits, and undoubtedly the fact that a committee is sitting, or is proposed to sit, upon the subject is a factor that will be taken into account.

Parliamentary Bills.—On Monday the following Bills were read a second time in the Commons:—Charing-cross, Euston, and Hampstead Railway Bill; City and South London Railway Bill; and Jarrow and Hebburn Electricity Supply Bill.

The South Lancashire Tramways Bill and the Airdrie and Coatbridge Tramways Bill were read a second time in the Commons last Friday, with a reference to committee regarding workmen's cars.

The Aberdeen Corporation Tramways Bill, Newcastle-upon-Tyne Electric Supply Bill, and the Wellingborough and District Tramroads Bill have been read a second time in the Commons.

In the House of Lords on Tuesday the Folkestone, Sandgate and Hythe Tramroads Bill was read a second time. In the Commons the Aberdeen Corporation Tramways Bill and the Newcastle-upon-Tyne Electric Supply Bill were read a second time.

Russia.—A company has just been formed in St. Petersburg with a capital of 2,000,000 roubles to be known as the Russian Electrical Company (Schuckert & Co.). The new company will acquire and carry on the electrical engineering works of Herr B. Zeitsetel.

Trade Announcements.—Mr. Edwin Cooper Wallis, of Central Works, Swinegate, Leeds, asks us to mention that for about five years his business has been quite distinct from that of Messrs. Cuttriss, Wallis & Co., Limited, (now in liquidation).

Universal Exhibition of 1900.—Messrs. E. P. Alexander and Son, chartered patent agents, 19, Southampton Buildings, W.C., write as follows:—"In France, as in many other foreign countries, the law requires a patentee to work his invention within a certain period under penalty of forfeiture of his rights. Compliance with this requirement not infrequently entails both trouble and expense, and it will therefore interest holders of French patents to know that, by a law passed last December, every person who shall have exhibited at the Universal Exhibition an article similar to that covered by his patent will be considered, so far as is necessary, to have worked his invention in France during the course of the Exhibition."

Water Re-coolers for Birkenhead.—We understand that the County Borough of Birkenhead have placed the order for the condensing and re-cooling plant for their electric power station at Rock Ferry, with Mr. Alfred Wenner, of 32, Oxford Street, Manchester. Mr. Wenner has the sole English rights for the sale of the Zschocke's patent wooden re-coolers, of which over 500,000 H.P. are in use in various places, including 30 electric power stations.

ELECTRIC LIGHT AND POWER NOTES.

Brighton.—A recently completed contract for electric wiring and fittings at the Town Hall amounted to £705; the extras came to £1,533 13s. 7d. This is truly a phenomenal occurrence!

A reservist employed by the Corporation was granted leave of absence during his service with the colours, and half wages allowed him during such period.

Bristol.—The resignation by Mr. George Pearson of his position as chairman of the Bristol Civic Electrical Committee occasioned general regret, and led to many expressions of hope that he might reconsider his decision. A meeting of the Committee, called to consider the matter, strongly urged Mr. Pearson to continue to preside over its affairs, and in this plea some of those who had rather prominently figured as Mr. Pearson's opponents joined. As a result of this pressure, Mr. Pearson has withdrawn his resignation.

Doncaster.—The Board of Guardians has resolved to borrow the sum of £22,545 for the execution of works for lighting the new workhouse by electricity, and for the erection of the new workhouse, in addition to the sum of £47,225 already authorised.

Edinburgh.—At a meeting of the Town Council last week it was reported that at May 15th the number of lamps joined on in one year would be over 70,000, a thing never heard of in connection with any similar undertaking in any country. With additional capital expenditure the cost per lamp would be £1 18s. 4d.

Germany.—Plans are under consideration for the establishment of a second central electric lighting station in the town of Frankfort-am-Main.

Glasgow.—It was stated at a recent meeting of the Town Council that with regard to the relative cost of electric lighting in Edinburgh and Glasgow the cost of each lamp in Edinburgh was £1 18s. 4d. as against £1 15s. 1d. in Glasgow. Bailie Mackenzie's statement to the Edinburgh Council, which we quoted on the 23rd ult., showed a very different result.

Harrow.—The Urban District Council has agreed to oppose the North Metropolitan Electric Power Sapply Bill.

Italy.—La Società Bergamasca fer Distribuzione di Energia Elettrici is the style of a company which has just been formed in Bergamo, Italy, with a capital of £150,000, to acquire and work a water-power-driven central station at Clanezzo, in the Brembana Valley. It is reported that Messrs. Schuckert & Co., of Nuremberg, are interested in the undertaking.

Little Lever.—The District Council has declined to join with other Councils in their opposition to the Lancashire Electric Power Company's Bill.

London.—County Council.—At a meeting last week, according to the *City Press*, the Highways Committee reminded the Council that in July, 1897, and February, 1899, estimates, amounting in all to £25,300, were approved for the installation of the electric light on the Victoria Embankment and Westminster Bridge, including the erection of the generating station, the provision of machinery, and the laying of the necessary mains. Tenders had since been accepted by the Council for the erection of the generating station and the supply of the necessary boilers and dynamos, and that part of the work was now in progress; and they proposed shortly to invite tenders for the supply of, and the work of laying, the electric lighting mains. As, however, the Embankment footway near Blackfriars Bridge and at some other places was being opened in connection with the works of the Charing Cross and Strand Electricity Supply Corporation, they thought that it was advisable that the mains required for the Council's electric lighting installation at those places should be laid at the same time. For that purpose the expenditure of a sum of about £250 would be necessary, including the cost of the cables, and the carrying out of the works. They recommended, "That the Council do sanction the expenditure on capital account by the Highways Committee of the sum of £250 in respect of a portion of the mains in connection with the electric lighting installation for the Victoria Embankment and Westminster Bridge; estimates in respect of which were submitted to and approved by the Council on July 13th, 1897, and February 15th, 1898." The Council approved.

The Highways Committee reported that notice had been given by the Kensington and Knightsbridge Electric Lighting Company, of intention to lay extra high-tension mains in Doulton casing surrounded by concrete, along Hunt Street, St. Ann's Road, St. James Square, St. John's Place, Portland Place, Ladbroke Road, Lansdowne Road, Uxbridge Road, Holland Walk, Duchess of Bedford's Walk, and Hornton Street. The Committee saw no objection to the proposed works, and recommended that the sanction of the Council be given to the works referred to in the notice. The Council adopted the recommendation.

Newington.—The Vestry has passed a resolution to the effect that the undertakers of municipal schemes should be empowered to wire consumers' premises upon a hire or easy payment system, and that the London County Council be requested to promote legislation enabling those metropolitan local authorities holding provisional orders to borrow money to carry out such work. Is Newington also among the Socialists?

Longton.—The Town Council has joined the Lancashire municipal corporations in opposing the Lancashire Electric Power Company's Bill.

Rainford.—The District Council has decided to offer no opposition to the Lancashire Electric Power Company's scheme.

Sheffield.—A gas explosion occurred last week in a manhole belonging to the tramway feeder system, but no one was hurt.

Shoreditch.—The Vestry on Tuesday approved the action of the Lighting Committee in appointing Messrs. Moss, Kershaw, and Wenborn to attend a conference convened by the Islington Vestry to consider the procedure of the London County Council in regard to loans. It was decided on the recommendation of the Committee to advertise for tenders for two Babcock & Wilcox boilers and steam pipes at an estimated cost of £2,100. The Officers Committee, in the course of a report on the accountant's department, stated:—

> The electric lighting undertaking being a commercial concern, it should, in the opinion of your Committee, be worked on a commercial basis, and accordingly a set of bought and sold journals and ledgers should be instituted, which would practically entail no more work than at present exists in the lighting department, whilst relieving a good deal of the pressure of book-keeping work in the accountant's office. All accounts for electricity supplied will be made out at the station, and sent to the accountant for collection, whilst all payments also will be made through his office; the accountant would be responsible for the periodical audit and checking of the accounts and books of the lighting department.

The Committee submitted a recommendation to this effect.

South Wales.—The Caerphilly District Council has resolved to support the South Wales Electrical Power Distribution Bill if the Council can secure clauses that they be supplied in bulk on the same terms as local firms. On the other hand, the Newport Chamber of Commerce has resolved to support the Town Council in its opposition to the Bill.

Southampton.—A Local Government Board inquiry was held at Southampton last week into the application of the Corporation for sanction to borrow £55,000 for the purposes of their electric lighting undertaking and other loans. There was no opposition.

Wigan.—The Corporation has decided to oppose the Lancashire Electric Power Bill.

Worthing.—A Local Government Board inquiry was held at Worthing on Friday last with reference to the application by the Town Council for sanction to borrow £13,400 for public lighting and other loans.

ELECTRIC TRACTION NOTES.

Battersea.—After a discussion extending over an hour and a half, the Vestry decided last week not to consent to the introduction of the London County Council Tramways No. 1 Bill unless

the Council agreed to omit the clause proposing the use of the overhead trolley system and to make other amendments in the Bill.

Aberdeen.—The Standing Orders Committee has allowed the Corporation Tramways Bill to proceed on condition that the promoters strike out their proposal to construct a tramway line over the bridge of Don, to which neither the Aberdeenshire County Council nor the Aberdeen District Road Committee had given their consent.

Bolton.—To avoid the dangers arising from the breaking of overhead electric wires, experiments have been made on the Bolton trolley wires by the borough electrical engineer, Mr. Arthur Ellis. He has, according the *Manchester Courier*, devised an appliance in the shape of a safety hanger, which he claims has both simply and effectually met the difficulty in question. Current is automatically cut off immediately a wire is broken. The Tramways Committee will, at an early date, test the new appliance with a view to its ultimate adoption in connection with the Bolton tramways.

Dublin.—The Dublin United Tramways Company have commenced operations for extending their Parkgate Street line.

Dublin and Lucan.—On 27th ult. the Board of Trade inspection of the Dublin and Lucan electric tramway system took place. The date of the inauguration of electricity as the motive power for the public traffic of the line has not yet been fixed.

Dudley and Wolverhampton.—The British Electric Traction Company hope to be able in the course of two months to run the electric cars from the tramway depôt at Sedgley to Dudley. The line between Sedgley and Wolverhampton will be reconstructed as speedily as possible.

Greenock.—Mr. W. M. Murphy has withdrawn from negotiations in connection with the leasing of the tramways, in consequence, it is understood, of his offer having been communicated to the other offerers.

Isle of Thanet.—The Board of Trade has confirmed, after modification, the Isle of Thanet Light Railways (Extensions) Order, 1900.

Islington and Electric Traction.—The clerk reminded the Vestry at the last meeting of the recent decision not to consent to the introduction of the London County Council Tramways (No. 1) Bill until certain concessions had been made by the Council. As the Council had conceded the question of overhead traction and agreed to insert a proviso not to use overhead wires, and as the Council's Parliamentary agent had given an undertaking that if the Vestry would consent to the Bill the Vestry would be in no way prejudiced in opposing the clauses, the clerk stated that he had given the Vestry's permission for the Bill to be introduced. This statement appeared to satisfy the Vestry, but in order to obtain a *locus standi* in regard to the clauses it was decided to seal a petition against the Bill.

Liverpool Overhead Railway.—The engineer to the Liverpool Overhead Railway Company has prepared, for the information of Parliament, the required estimates showing the capital that will have to be expended in the event of sanction being given to the proposals contained in this company's Bill of the present session. The total estimated expenditure is put down at £113,583, of which £92,971 will be spent on a little over one mile of extensions, and £20,612 upon the widening at their Pierhead station. The estimates show that of the total sum £12,400 will be expended on additional station accommodation. To meet this expenditure, the Bill provides for the creation of £120,000 additional share capital.

London.—The Standing Orders Committee of the House of Commons has allowed the South-Eastern Metropolitan Tramways Company's Bill to proceed, provided that the whole of the proposed tramway extensions are struck out. These extensions covered over 11 miles of new lines in Lewisham and the County of London, including a line to the Crystal Palace. The estimated cost of constructing the extensions was £91,971. As amended by this decision, the Bill now proposes to empower the company to adapt their system for electric traction. The estimated cost of the necessary alterations and electrical equipment is put down at £158,029.

Newcastle-on-Tyne.—The New Tramways Committee is proceeding with the electric tramway scheme by placing contracts. A contract for laying the new tramways has been given to Mr. Edward Nuttall, of Manchester, at £105,257. Addressing the Council last week, Mr. Cail said the contract was for laying 22 miles of rails. The Parliamentary estimate was £220,000. Mr. Nuttall's tender was £105,000. They would have to add £33,000 for rails, £5,000 for junction points, and contingencies would bring it up to £151,000, as against the estimated £220,000—a saving of about £70,000. Mr. Nuttall was, he said, prepared to start the work at once. The work was to be completed in 12 months from March next, under a penalty of £100 for every week's delay.

Mr. Cail presented the report of the New Tramways Committee recommending that the following tenders be accepted:—Tender of the British Westinghouse Company, Limited, for one 2,000 H.P. generator, with engines made by the Wallsend Slipway and Engineering Company, Limited, contract price £16,230; and a tender by the Westinghouse Company for two 1,000-H.P. generators, with engines by Victor Coates & Co., Limited, of Belfast, contract price, £16,450. The tenders were submitted at the last Council meeting, their acceptance having been recommended by Mr. Hopkinson, the electrical expert. It was stated, however, that another firm had offered to provide the generators for considerably less money. In reply, it was stated that the Westinghouse Company's tenders provided for more than the Committee asked; and to this it was objected that the firms that had kept to the specifications given when tenders were asked for should not on that account be penalised. Ultimately the tenders were referred back to the Committee, who now reported again according to their original decision that these tenders should be accepted.

Mr. Cail said the Committee had been accused of trying to rush the matter through the Council. They were not engaged in ordinary committee work; they were engaged in emergency work. The people were crying out for new tramways, and they had done all they could to push on the work, but were not rushing it. Dealing with the Committee's recommendations, he said they had engaged an expert, and that entailed certain responsibilities. Mr. Hopkinson strongly advised them to accept the Westinghouse machine, saying that at the respective prices it was cheaper than any other. Recently, Manchester, Plymouth, and Glasgow, on the advice of their experts, had given contracts to the Westinghouse Company, in preference to others. If the company did not follow the advice of the expert in technical matters, they would put themselves in the position of posing as experts upon matters about which they knew nothing. He moved the adoption of the report. Mr. J. J. Gillespie seconded the motion.

Mr. J. F. Weidner thought the reasons against the report were stronger now even than they were at the last meeting. They had been able to borrow £400,000 very cheaply; but, unless they gave out their orders very carefully they would soon be within measurable distance of £500,000. He would have preferred the giving of the whole work to one firm, to do the complete installation at a fixed price, under a heavy penalty. If they had done that, he believed it would have saved the town many thousands of pounds. He asked the Council whether they were sure that the extra work would be got out of the Westinghouse machine. They had only the assurance of Mr. Hopkinson and the Westinghouse people. As business men, they should have more information as to why they were to pay £32,680 for these machines, when they could get them for £4,000 less. The Schuckert Company had stuck to the specification, but the Westinghouse Company offered something else. He moved, as an amendment, that the contract for one 2,000-H.P. generator be given to the Westinghouse Company, and that the contract for two 1,000-H.P. generators, with the Coates engines, be given to the British Schuckert Electrical Company. Mr. Fitzgerald seconded the amendment.

Mr. Cairns said that if they went against Mr. Hopkinson's recommendation, they would be relieving him of the responsibility which they paid him to undertake. They should realise that it was the core of the whole system they were now dealing with. They should have the machines of the same type. As a commercial man, he would prefer a machine that would stand more loading than he asked, and he would have to take that into account in estimating its value to him. In Newcastle they had heavy gradients, and they would be far better if they were absolutely on the safe side. Finally, they should stand or fall by their adviser.

Alderman Jos. B. Ellis said it would be very unfair, without a very substantial reason, to relieve Mr. Hopkinson of the responsibility for which they were paying him. He attended the meeting of the Committee at which Mr. Hopkinson made his explanation. At the close of Mr. Hopkinson's statement, he (Alderman Ellis) pointed out that he had not touched the kernel of the question, namely, as to why they were to spend the extra £4,000. Mr. Hopkinson replied that the extra power provided in the Westinghouse machine would postpone the further expenditure on generating plant which the growth of the tramways service would inevitably demand, and towards which the Committee had already made some provision over the original estimate of power in view of the Gosforth extension and street lighting. That put quite a different light on the matter. These should have been provided for in the original estimate, but were not. If this would be provided for by the Westinghouse machine at the extra cost of £4,000, they should give the contract to the Westinghouse Company.

The Council divided, with the result that 8 voted for Mr. Weidner's amendment, and 34 against. The amendment was consequently lost, and it was agreed to give the contracts to the Westinghouse Company.

Newport (Mon.).—After further deliberation regarding the question of a site for the electric tramway power station, the matter has been brought before a meeting of ratepayers, which has voted for the Corporation Road site.

Paisley.—The British Electric Traction Company have intimated withdrawal of their proposal to carry out their tramways scheme in Paisley and district.

Portsmouth.—There having been a further hitch in the negotiations between the Tramway Companies and the Tramway Committee *re* the purchase of the system, the Committee has now reported to the Corporation that the time has arrived when the course of action must be decided on, and they therefore recommend that proceedings be taken against the tramways companies to obtain a decision of the Court upon the question raised by the tramway companies, and to require possession of the tramways to be given to the Corporation under the Portsmouth Corporation Tramways Act, 1898.

On Tuesday the motion for the adoption of the report was put and carried at the Council meeting.

Southampton.—The Tramways Committee has reported the receipt of a letter from the General Post Office, notifying that the alteration to the Post Office wires, together with the cost of fuses rendered necessary by the Corporation tramway operations, would cost £62, and that the expense would under the statute fall upon the Corporation. The communication was referred to the electrical engineers to report upon.

Tipton.—A meeting of the Urban District Council was held last week, when the Tramways Committee recommended that all necessary proceedings be taken enabling the Council to acquire the portion of the tramways undertakings within the district of the Council, and that notice in writing be given to the promoters of the South Staffordshire and the Birmingham and Midland Tramway Companies respectively with respect to the purchase. Mr. Doughty, in proposing the adoption of the recommendation, said he believed the undertakings within the parish could be purchased for £7,000, and that the necessary electric equipment and contingencies could be provided for a further £18,000, making £25,000, on which outlay there would be a handsome profit. Mr. Powell seconded, remarking that no doubt the electric tramway company would ultimately become the owners, and that, as the result of the passing of the resolution, the company would be compelled to deal generously with the Council. The resolution was carried by a large majority.

Tramway Statistics.—The *Financial News* abstracts as follows a Board of Trade return which has been recently issued showing that on June 30th last a sum of £26,597,000 had been authorised to be spent on tramways in this country, of which £18,053,000 had been paid up—£8,517,000 as shares and £9,536,000 as loans and debentures. The paid-up capital works out at £16,090 per mile, an increase of £1,128 on the previous year's figure, due largely to the fact that a considerable portion of the 58 miles of new line opened is intended for electric traction, and is, therefore, necessarily on a more expensive capital basis. There were in June last 44,171 horses engaged in tramway work in this country, but the number of locomotives fell from 586 to 584 in the 12 months. Of passengers there were carried 924,820,247 against 858,485,542, and 616,972,830 in the two previous years. The following table shows the aggregate receipts, expenses, and net receipts for the years ended with June, 1899, 1898, and 1884. It is satisfactory to find that the passenger receipts per mile last year work out at a substantially higher figure than in the previous year—viz., £4,200, against £4,120 in the previous return, while the expenses were £18 decrease. An encouraging feature is the fall of 2, to 75 per cent. in the percentage of expenses to gross receipts:—

Year to June 30th.	1899.	1898.	1884.
Receipts	£4,879,603	£4,560,136	£2,618,408
Per mile	4,350	4,284	3,222
Expenditure	3,675,559	3,507,895	1,975,679
Per mile	3,277	3,295	2,436
Per cent. of gross receipts ..	75	77	74
Net receipts	1,204,043	1,105,231	637,849
Per mile	1,073	989	786
Per cent. of gross receipts ..	25	23	24

Waterloo and City Railway.—In the Commons last week a question was asked by Mr. Keswick as to the accommodation on the Waterloo and City Railway. Mr. Ritchie, in reply, said that the Board of Trade are not in a position to interfere in such a matter relating to the management of a railway. They understand, however, from the manager of the London and South-Western Railway, that the number of trains run from Waterloo to the City is as great as can be run with safety, and that in consequence of complaints of overcrowding, steps have been taken by the company to regulate the number of persons to be admitted to the platform at one time—an arrangement which, it is stated, has been attended with satisfactory results.

Wolverhampton.—The Corporation Tramways Committee have now commenced to move with the object of improving and extending the present tramway system. The lines, by the terms of the recent arbitration, come into the hands of the Corporation on May 1st, and it is felt that immediate steps should be taken in view of that fact. As a preliminary, the Committee at a recent meeting appointed Aldermen C. T. Mander and Craddock, and Councillor Parkyn a sub-committee to obtain information and generally get up details with the aim of improving the present tramway system as soon as it gets into the hands of the Corporation. It was also felt by the Committee that it would be desirable to push on with the electric traction which has been decided upon, and after discussion it was decided that this could best be done by making a start at once on the new line proposed to be laid from Darlington Street to Tettenhall. This could be commenced immediately, and would be well advanced when the present system is taken over. This course would also have the advantage of presenting an alternative route to Tettenhall when the time for relaying the present lines and putting up the electrical gear on the Tettenhall Road line came. After considering the matter and the increased cost of materials at the present time, which will add to the original estimate for the work by some £4,000, it was felt by the Committee that that should not stand in the way of an immediate start of the work, and it was therefore decided to procure tenders at once.

TELEGRAPH AND TELEPHONE NOTES.

American Pacific Cable Scheme.—Reuter's Washington correspondent says that the Committee of the Senate on Naval Affairs has ordered a favourable report on a Bill for the construction of a Pacific cable under the direction of the Navy Department. The line is to be a Government cable. The Bill provides for immediate construction only from San Francisco to Honolulu, but it contemplates an ultimate extension to the Philippines and Hong Kong.

Australian Cable Matters.—Reuter's Sydney agent says that the Press of Sydney is unanimously in favour of the Eastern Extension modified scheme in connection with the cable to Australia and the reduction of rates as approved by all the Australasian Governments with the exception of Queensland and New Zealand.

Australian Telephones.—The *British Australasian* says that direct telephonic communication between Melbourne and Bendigo has been established. The line is 100 miles long, the longest telephone wire in the colony.

Bristol Telephones.—The new offices of the Telephone Company, in Telephone Avenue, Baldwin Street, will be opened in the course of two or three months, and there will be provision for 6,500 subscribers, capable of extension to meet the requirements of 13,000. The work would be performed from accumulators at the central office, instead of batteries at the subscribers' premises. The exchanges at Clifton, Bishopston, and St. George will be closed, and all worked from the central exchange.

Cable Communication with the Cape.—Last week, on the supplementary vote of £10,000 for subsidies to certain telegraph companies coming before the House of Commons, Mr. Caldwell asked for an explanation of these subsidies. Mr. Hanbury, replying, said that when the Transvaal war broke out the Eastern Telegraph Company were laying another wire between St. Helena and Cape Town, and in the ordinary course the vessel which was laying that cable would afterwards have returned and laid the wire between St. Helena and Ascension. If that course had been followed the result would have been to delay by about three months the laying of the last link in a cable which would give an alternative route. In order, therefore, to get this alternative route open as soon as possible, they arranged with the company that they should send an extra ship out from England to lay the cable between Ascension and St. Helena, concurrently with that between St. Helena and Cape Town, and they undertook to pay whatever the cost might be up to £15,000, if the wire were laid by Christmas instead of, as was originally intended, by March 31st. The company agreed to those terms, and, as a matter of fact, the cable was laid by December 15th or 16th, and instead of the extra cost involved being £15,000, it only amounted to £10,000. The vote was agreed to.

The Cape-Australia Cable.—The *Times* Melbourne correspondent telegraphed on March 2nd that Mr. Chamberlain had forwarded and endorsed a protest from the Pacific Cable Board against the Eastern Extension Company's concessions in connection with the Cape-Australia cable. The Premiers of Victoria and New South Wales were considering the subject.

Cardiff Telephones.—As stated last week, the Parliamentary Committee has had before it the question of municipal telephones. Mr. J. M. Maclean wrote saying that Mr. Hanbury had asked him what further steps the Corporation intended to take in the matter. The Postmaster-General also wrote asking for a definite statement of intention.—In answer to Mr. S Robinson, the town clerk said that he had no figures as to the financial aspect of an arrangement under which the Corporation might take over a telephone system (which, the Postmaster-General's letter stated, would cover Cardiff, Penarth, and Barry). The rentals of the Cardiff district amounted to £1,851 10s.—The Committee decided to hold a special meeting to consider the whole question.

Hull Telephones.—The Chamber of Commerce has appointed a Committee to obtain information as to a suggested municipal telephone system.

The London Telephone Service.—In the House of Commons last week, according to the *Times* Parliamentary report, Mr. Hanbury, answering Mr. Kimber, said:—"Large contracts have already been made, and others will very shortly be concluded, for telephone plant and underground wires involving an expenditure of about £500,000 out of the £1,250,000 which the London exchange will probably cost. Some delay has necessarily been caused by negotiation with the large number of vestries, who in the first instance control the granting of wayleaves, but these having given their consent the work will now be carried on at once over the whole of the large London area. The Post Office expect to afford telephonic communication by the end of the year in nearly the whole of the City area, the Strand and Charing Cross district, Westminster, Chelsea, Belgravia, South Kensington, and Kensington to Notting Hill, West Kensington, Brompton, Fulham, Wimbledon, Putney, Barnes and Mortlake, Kew, Richmond, Twickenham, Kingston, Norbiton and Surbiton, Hammersmith, Turnham Green, and Chiswick. I will have a map placed in the tea room showing this large district, and also the general plan of the wires in the whole of the London area. In view of the competition with the National Telephone Company, it would be obviously unwise to disclose the rates to be charged until it is necessary to canvass for subscribers. There is no power to compel the National Telephone Company to allow intercommunication between their exchanges and that of the Post Office; but in view of the great importance to the public of such intercommunication, all reasonable steps will be taken to effect it, and the co-operation of the London County Council, as the chief road authority, may be of considerable assistance in bringing about that desirable result."

The Pacific Cable.—In the House of Commons on Monday Mr. Hogan asked the Secretary for the Colonies whether he had received protests from the Canadian and New Zealand Governments against the concessions recently granted to the Eastern Extension Company in Australia as being likely to militate seriously against the financial success of the Pacific cable, in which the Imperial, the Canadian, and the Australasian Governments were joint partners; whether, in view of those protests, it would still be possible to revoke

the concessions and prevent any further complications of a like character; and whether he had received a reply to his message to the Australian Governments on the subject.—Mr. Chamberlain said that he had received protests of the nature described from Canada and New Zealand. He was informed by the Government of New South Wales that the arrangements with the Eastern Extension Company were not yet concluded, though it was aware that the decision of the recent conference of Prime Ministers was generally favourable to the proposals of the company.

A Reuter's despatch from Ottawa, March 7th, says that the Press despatches from Australia and England indicating the probability of concessions being made in Australia for the construction of telegraphs are causing great uneasiness in Canada. The subject was discussed in the House of Commons there, and the Government were pressed closely to state their attitude. The opinion was expressed that the grant of the concession would change the basis of the Pacific cable question, would dissolve the partnership, and would destroy the present scheme, and that whatever Government were responsible for the failure would be called to strict account. Mr. Mulock, the Postmaster-General, assured the House that the Government were adhering firmly to the original scheme, and were raising objections in all quarters to any departure from it. The situation, added Mr. Mulock, appeared critical, but not hopeless.

The Pacific Cable Scheme.—Further correspondence relating to the proposed construction of a cable across the Pacific Ocean was published on 2nd inst. in the form of a blue book consisting of 50 pages. The correspondence opens with a letter dated May 9th, 1899, from the Anglo-American Telegraph Company, Limited, to the Colonial Office, and closes on November 25th with a copy of the instrument appointing a committee to consider the scheme suggested by the Committee of 1896. The substance of the various despatches has from time to time been published since May last. The members of the Committee are:—The Earl of Selborne, Under Secretary of State for the Colonies; Sir Francis Mowatt, Permanent Secretary to the Treasury; Sir George Herbert Murray, Secretary to the Post Office; the Earl of Aberdeen; Baron Strathcona and Mount Royal, High Commissioner for Canada; Sir Julian Emanuel Salomons, Q.C., Agent-General for New South Wales; Lieut.-Gen. the Hon. Sir Andrew Clarke, Agent-General for Victoria; and the Hon. William Pember Reeves, Agent-General for New Zealand; Sir Francis Mowatt acting as chairman. It is pointed out that the duty of the Committee is to consider the following points:—(1) The cost of (*a*) laying and (*b*) maintaining the line, and whether as a single or duplicated cable, while in order to arrive at a conclusion on this point the Committee will be at liberty, if it thinks proper, to advertise for tenders, on the understanding, however, that no tender can be accepted without reference to the several Governments concerned; (2) the rates to be charged for messages, and the revenue which the cable may be expected to earn therefrom; (3) the steps which should be taken in order to secure that all messages between this country and Australasia should be sent solely through British territory or through cables owned and worked by British companies; and (4) the framing of a scheme for the permanent administration and working of the cable when laid. The conclusions arrived at by the Committee on these points will be laid before the several Governments concerned, who will then decide what further steps should be taken. All questions as to the mode of raising the capital necessary for the undertaking are reserved for the Imperial Government alone.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies:—		
Trinidad-Demerara (1891 duplicate)	Oct. 23, 1899	
Jamaica-Colon	June 30, 1899	
Mole St. Nicholas-Cape Haitien	March 6, 1900	
Santiago de Cuba	March 7, 1900	
New York-Hayti	Feb. 26, 1900	
Cayenne-Pinheiro	Oct. 11, 1899	
Cayenne-Paramaribo	Feb. 16, 1900	
Ceara-Maraham	Feb. 20, 1900	
Para-Maraham	March 2, 1900	
Latakia-Cyprus	June 20, 1899	
Tarifa-Tangier	Jan. 2, 1900	
Landlines.		
West Indies:—		
Communication with Port de Paix (Haiti)	Feb. 26, 1900	
South African:—		
Communication with Mafeking and beyond	Oct. 13, 1899	
Communication with all offices beyond Orange River	Oct. 18, 1899	
Communication with north of Mooi River (Natal)	Oct. 22, 1899	
Communication beyond Burghersdorp (Cape of Good Hope)	Nov. 7, 1899	
Communication beyond Estcourt (Natal)	Nov. 7, 1899	
Communication with Bluefields (Nicaragua)	July 7, 1899	
Communication with all offices of Columbia	Oct. 23, 1899	
Communication with Colombia beyond Buenaventura	Jan. 22, 1900	
Communication "*vid* Hanekine" interrupted on Persian Territory	Feb. 24, 1900	
Serena-Valparaiso	Jan. 16, 1900	

Underground Telegraphs.—The Edinburgh Chamber of Commerce meeting has made a remit to the directors to consider the question of securing underground telegraph wires, and when the time is ripe, to co-operate with other chambers in a request to the Government to have the underground cable continued northward from Birmingham to Scotland.

CONTRACTS OPEN AND CLOSED.

OPEN.

Birkenhead. — March 20th. The Corporation wants tenders for the supply and erection of overhead tramway equipment. See "Official Notices" to-day.

Dartford.—March 27th. The Urban District Council is inviting tenders for the supply of Lancashire boilers, pipework, surface condenser, two high speed steam dynamos and motor boosters, batteries, switchboard, overhead traveller, mains, conduits and roadwork, arc lamps and posts, and station lighting. See "Official Notices" March 2nd.

Dublin.—April 26th. The Electric Lighting Committee wants tenders for six Lancashire and four water-tube boilers and two economisers; two 1,000-KW. and two 500-KW. low speed polyphase generators for the electricity supply scheme. See "Official Notices" to-day.

Dundee.—March 21st. The Town Council wants tenders for feeder mains, joint boxes, and underground conduits for tramway purposes. See "Official Notices" to-day.

Durban (Natal).—April 2nd. The Corporation is inviting tenders for 1,900 tons of steel girder rails, 64 tons of fishplates (bolts, bonds, &c.), 407 loads Australian hardwood stringers, &c, also the laying of same for 14·36 miles of single track, and bonding 2·96 miles of equivalent existing single track, the Corporation laying concrete foundations and making up roadway. See "Official Notices" February 9th.

Fulham.—March 19th. The Vestry wants tenders for 100 5-ampere meters, 100 10-ampere meters, and 50 20-ampere meters. See "Official Notices" to-day.

Hull.—March 22nd. The Electric Lighting Committee wants tenders for two steel Lancashire boilers. See "Official Notices" to-day.

Islington. — March 14th. The Vestry wants tenders for a year's supply of electrical stores. See "Official Notices" March 2nd.

Lancaster.—March 22nd. Tenders are wanted for three Lancashire boilers, superheaters, economiser; three 175-B.H.P. steam dynamos, booster, switchboard, pumps, cranes, &c.; accumulators; feeder mains (solid system); and wiring of buildings, all for electric lighting purposes at the Rainhill County Asylum. Particulars will be found among our "Official Notices" February 23rd.

Leeds.—March 21st. The Tramways Committee wants tenders for one, two, or three steam dynamos. See "Official Notices" February 23rd.

Plymouth.—March 22nd. The Electricity Works require tenders for 12 months' supply of alternating current meters and transformers and arc lamp carbons. See "Official Notices" to-day.

Southampton.—March 16th. The Corporation invites tenders for the supply of stores, &c., required in the Electricity Department during a period of 12 months, according to specification and conditions to be obtained upon application at the Electric Light Works, Back-of-the-Walls.

South Shields.—March 12th. The Corporation wants tenders for high and low tension cables and ducts. See "Official Notices" February 23rd.

Spain. — March 12th. The municipal authorities of Almaden (Ciudad Real province) are inviting tenders until March 12th for the concession for the electric lighting of the town during a period of 10 years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Almaden (Ciudad Real).

Swansea.—March 19th. The Corporation invites tenders for insulated electric mains, conduits, junction boxes, &c., for electricity supply. See "Official Notices" March 2nd.

Walthamstow.—March 23rd. The Council wants tenders for the supply and laying of electric lighting cables. See "Official Notices" to-day.

CLOSED.

London.—The Shoreditch Vestry have received the following tenders for the supply of carbons for the ensuing year:—The General Electric Company (accepted), Johnson & Phillips, Sloan and Co., Crompton & Co. The tenders were based upon a schedule of prices.

(*Continued on page* 405.)

THE COUNTY OF LONDON ELECTRIC LIGHTING COMPANY'S ELECTRICITY WORKS.

This company was formed in 1890, and obtained provisional orders in 1892 for the united parishes of St. James and St. John, Clerkenwell, and for St. Luke, Middlesex, on the north side of the Thames; and on the south side, orders for the district of the Wandsworth District Board of Works, and for the parish of St. George-the-Martyr, Southwark.

In 1894 Mr. A. J. Lawson was appointed engineer and manager of the company (a post which he held until his resignation in November, 1889; in 1895 and 1896 further applications were made for various other London districts, and provisional orders were obtained for that of the St. Olave District Board of Works, for the parish of St. Giles, Camberwell (the largest parish in London), the district of the Limehouse District Board of Works, and the parish of St. George-in-the-East and the hamlet of Mile End Old Town, as well as an order for the County of London northern extensions, which included a small piece of Shoreditch, and part of the district of the Holborn District Board of Works.

In 1897 a further order was secured, which was confirmed in the Session of 1898, for the western part of the Holborn District Board of Works; this order also included a portion of the parish of St. Giles lying to the north of Oxford Street and High Holborn and adjoining the Holborn District Board's territory on the east side, St. Pancras on the north, and Marylebone on the west, where the boundary line was the centre of Tottenham Court Road.

The work of laying mains in both the Holborn and St. Giles districts was commenced in the early part of 1899, by which time the mains in the eastern portion of Holborn, for which an Order had been granted in 1897, were laid.

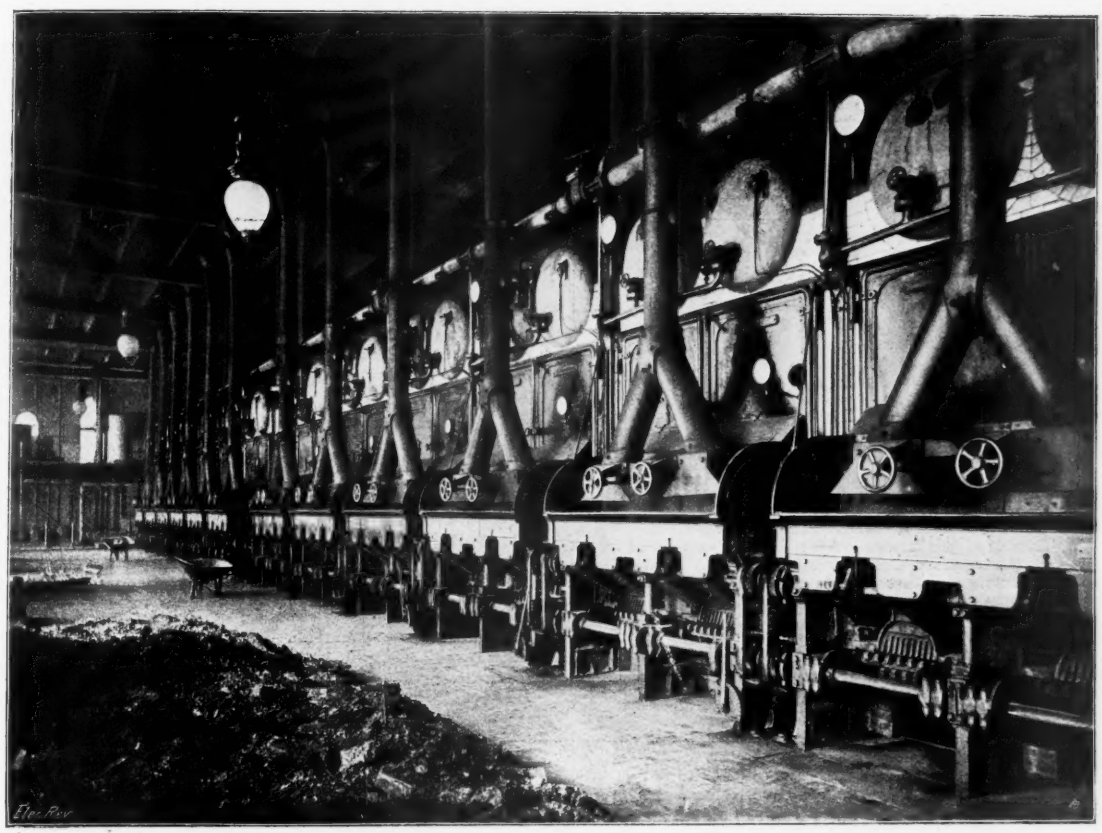
By 1898 orders had thus been obtained by the company for 11 of the 45 London districts, and at the present date work in seven of these districts has been completed.

The plans of the engineer and manager of the company, Mr. A. J. Lawson, provided for the supply of all the districts on the north side of the River from one station at City Road, and of all districts to the south of the Thames from the station at Wandsworth, until such time as the company might be required, under an award by the Board of Trade, to provide for a separate station in the parish of Camberwell, when it was intended that the Wandsworth and Camberwell stations should be interconnected and run in parallel during the winter at times at maximum load, but that each station should be shut down during part of the summer in order to undergo a complete overhaul before the re-commencement of supply in the autumn.

City Road Station.

In the latter part of 1894 the premises formerly used as a coal wharf by Messrs. Ricketts, Smith & Co., and known as Oak Wharf, City Road, were secured as a site for a generating station, and plans were submitted to the London County Council in the early part of 1895. Owing, however, to the restrictions placed upon the company as to building lines, &c., it was necessary to immediately take over the adjoining wharf in order to put down the present station, for which new plans had then to be submitted. These were approved by the County Council and local authorities in 1895, and building work was commenced, but owing to strikes of builders' workmen it was not until the beginning of 1897 that the buildings were completed, nor until September of the same year that a supply was available from the company's own plant, although current had been given to consumers from the company's mains by arrangements with a neighbouring company for nearly two years prior to that date.

The site of the station occupies 303 feet 6 inches along the canal basin of the Regent Canal Company, 165 feet along Graham Street parallel to the canal, 140 feet from the canal to Graham Street at the northern end, and, being cut diagonally by City Road at the south end, the length along City Road to Graham Street is 198 feet 9 inches. It was decided to construct the buildings within what is practically a watertight tank, formed by thick concrete foundations overlying the whole area of the land, and with



Battery of 12 Water-Tube Boilers, with Mechanical Stokers.

water and moisture-proof walls towards the canal, along which a coffer-dam had to be placed by the builders.

Mr. Lawson's plans provided for a complete set of offices for the accommodation of board, management and executive staff, as well as for offices for the engineering staff employed on the northern side of the Thames, and storage rooms for material.

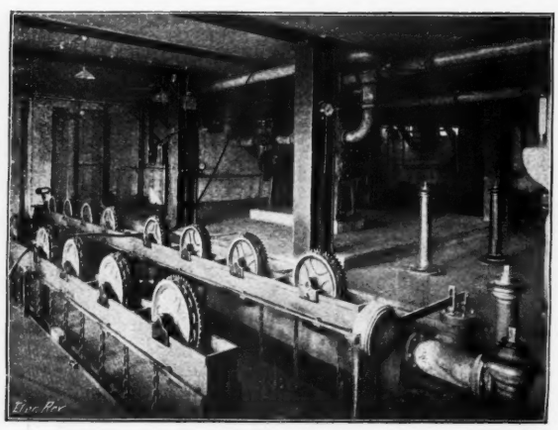
The buildings, which were designed by the company's architect, Mr. C. Stanley Peach, F.R.I.B.A., in consultation with the company's engineer, are constructed throughout of best selected stock bricks and Portland cement, and are practically fireproof. Messrs. Mowlem & Co., of Westminster, were the building contractors.

The chimney is a massive structure, in section of a square form with the corners cut off, both internally and externally, and is 200 feet in height, with an internal diameter of 12 feet between the parallel sides at the top.

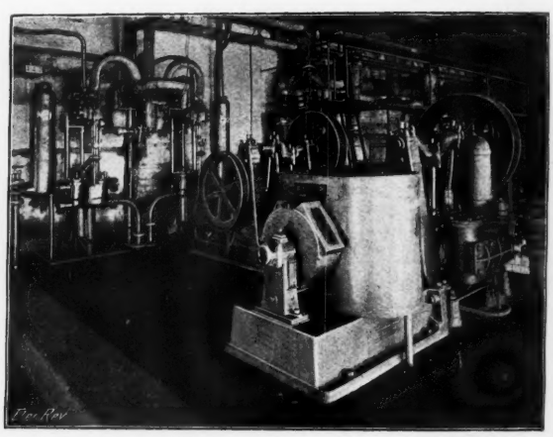
The boiler room is a two-floored building with mezzanine floor for a short distance at one end, seen in our illustration. The interior of the engine room and switch room is lined with glazed bricks and tiled over with adamant tiles, thus securing one of the greatest desiderata in engine rooms of generating stations, *i.e.*, cleanliness. All floors throughout the building are of concrete on iron joists, the only woodwork being that used for doors and door posts, wood block floors laid over the concrete, and the boarding for carrying the slates over the engine room roof.

The boiler room adjoins the canal, and is a room 198 feet 3 inches in length by 41 feet 4 inches in breadth, with space at one end for a double set of economisers and gearing, of Messrs. Green and Co.'s make, above which there is a short length of flooring upon which the feed pumps are placed. From this end to the extreme north end of the building there are now installed two batteries of six boilers each of Babcock & Wilcox make, with room for a third battery of five boilers. These are fired automatically by Vicars' stokers, the hoppers of which are supplied with coal through vertical shoots from the coal store above. These stokers have hitherto been driven by two Chandler enclosed engines, but in order to avoid the loss by condensation in long lengths of steam

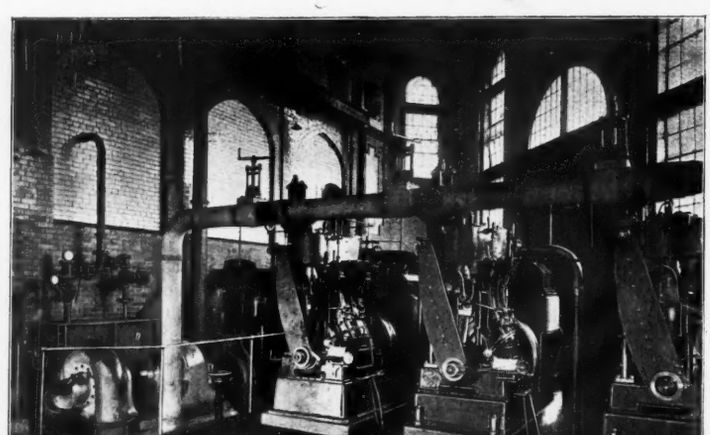
Coal bunkers, Conveyers, &c.



Motor-Driven Economiser Gear, Damper Regulators, and Oil-Separators.



Electrical and Steam Feed Pumps.



Exciter Sets and Centrifugal Pumps.

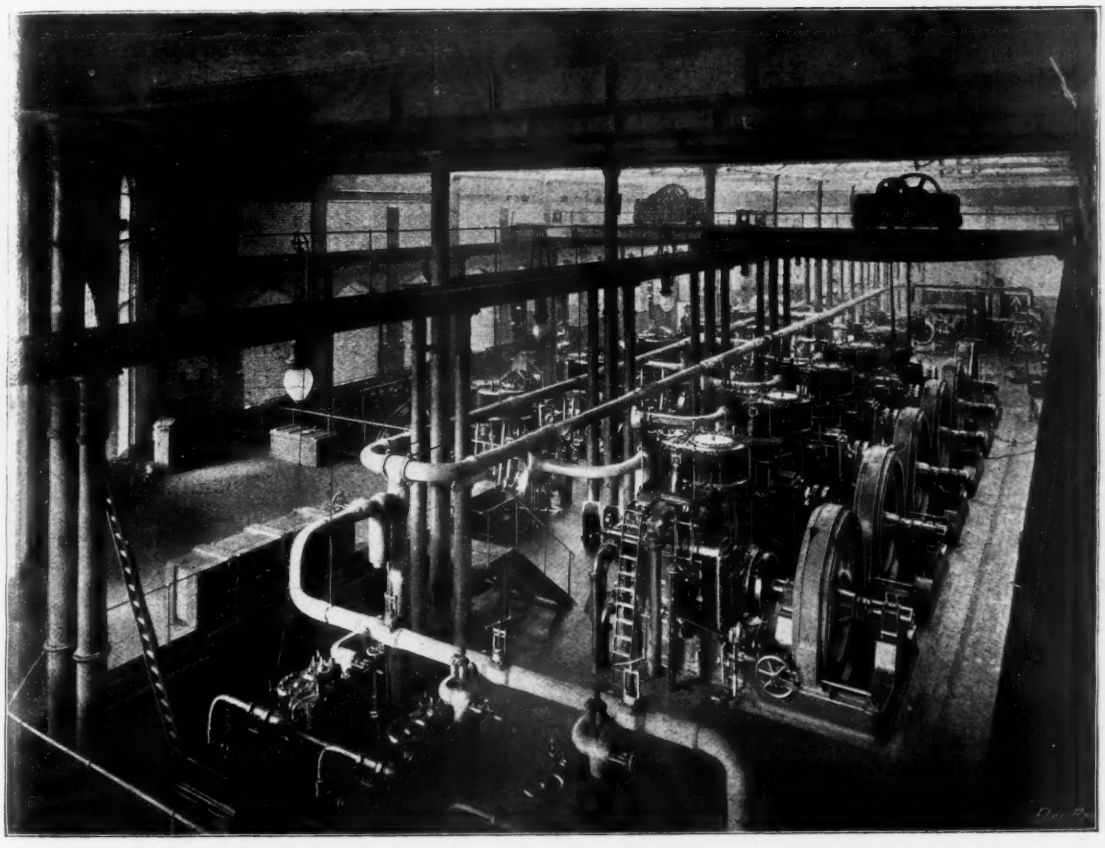
pipe, it was decided to replace at least one of these engines by a small motor, to be supplied from the continuous current mains. The stoking floor is some 2 feet above the level of the water in the canal basin, and the ash and clinker are wheeled out into steel barges belonging to the company. These barges are used alternately for removing the ashes and bringing up coal from the lower reaches of the river.

Between the boiler fronts and the wall along the canal there is sufficient length, and no more, for the withdrawal of tubes from the boilers. Six of the boilers are fitted with superheaters, and the remainder are to be similarly equipped.

On the pump room floor, of which we give a view, there are placed two Weir steam feed pumps, each capable of supplying 4,000 gallons per hour against a pressure of 150 lbs. per square inch, as well as two Hayward and Tyler three-throw feed pumps of the same capacity driven off the continuous current mains by electric motors of the Electric Construction Company's and the Brush Company's

to be rather wasteful of steam; it is therefore proposed to replace it by a small motor with automatic switch operated by the rise and fall of the water in the sump.

In order to deal with the large amount of coal which is annually consumed, and to provide sufficient storage accommodation, the coal store has been built over the boiler room throughout its whole length. To render this portion of the building fire-proof, the flooring is composed of brick arches, between iron girders passing from one wall of the boiler room to the other, sheeted over with steel plates. The roof is composed of corrugated iron on steel principals and purlins. Ventilation from the boiler room below is carried out by means of a box composed of steel plates leading into the open air at the back of the coal store. A Blackman fan is used to remove the heated air from the pump room. Ample ventilation is also provided for the coal in the bunkers by means of perforated iron pipes, and the roof is furnished with louvres. The bunkers are divided longitudinally by a



Bird's eye View of Engine Room

manufacture, controlled by switchboards in the boiler house. On the same floor there is a large hot-water tank into which the condensed steam from the engines is returned, and where it is freed as much as possible from any cylinder oil which may come along with it, while underneath in the feed water ring mains are two oil filters of Messrs. Railton & Campbell's manufacture, similar to those generally used on ocean steamers. Off the pump room floor short ladders lead to the platforms, from which the screw-down steam valves from the boilers are manipulated. In addition to the stop valve, a non-return valve is also inserted in the steam pipe from each boiler. The water-feed valves of each boiler are operated by handles on the boiler room floor, attached to long stems provided with universal joints. The blow-off pipes from the boilers are laid to a tank near a sump, into which any water that may percolate through the concrete foundations is drained. When cooled in this tank the blow-off water is allowed to drain into the sump, whence it is lifted, at present, by means of a steam injector which, however, is found

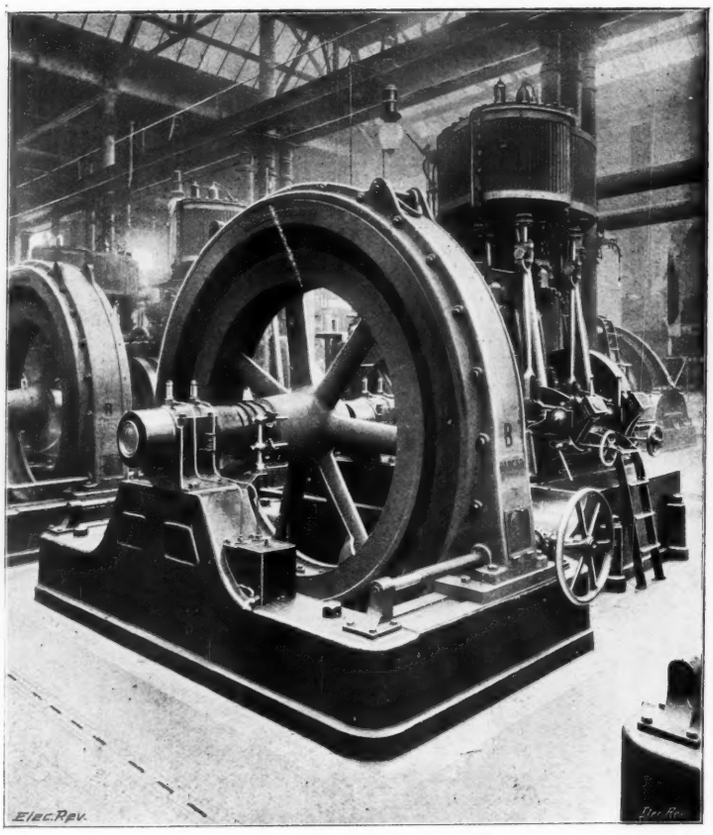
passage laid with steel rails, upon which runs an automatic recording weighing machine of Messrs. W. T. Avery's make. This machine, which was specially designed by Mr. Lawson, is so constructed that all coal, even the smallest, must be discharged on each opening of the door, and it automatically records the number of times the door has been opened; this record must correspond with the number of printed tickets of weight handed in by the trimmer at the end of each eight hours' shift. Into the bunkers on each side (which are divided transversely by steel plate bulkheads), the coal is conveyed by a Bennis automatic conveyer fed from the barges in the following way:—

A powerful hydraulic crane is stationed on the platform abutting on the end of the coal store at the edge of the wharf, the crane being fitting with Hone's patent grab. The *modus operandi* of the gear is as follows:—Swinging round and falling at a high speed, the grab is dropped on to the fuel in the barge, and settles to its charge. The motion being reversed, the grab closes in and shuts fully loaded. The crane slews round while the grab is rising, and on the grab coming

is lined with glazed bricks and tiled over with adamant

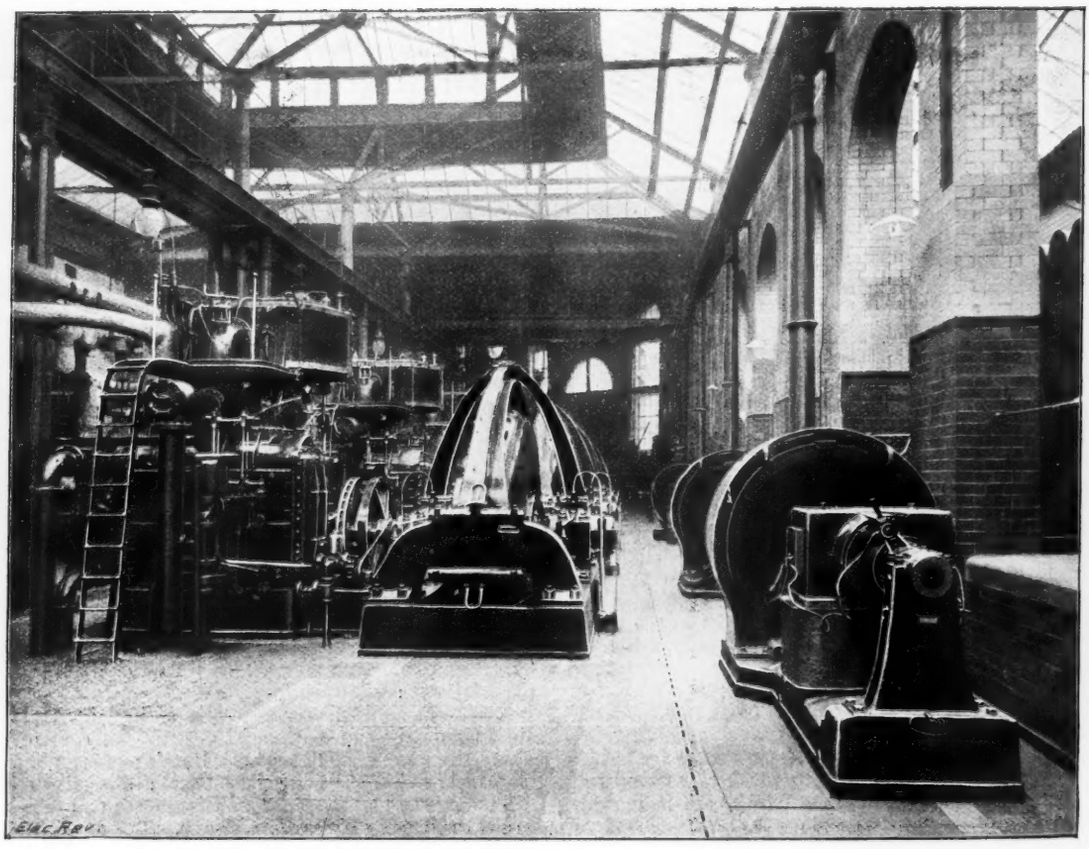
to avoid the loss by condensation in long lengths of steam

over the wrought-iron hopper (fitted with spreading sides to prevent fuel splashing over), the releasing gear is operated by the crane man, and the grab deposits its contents in the hopper, which takes the impact of the fuel before it reaches the weighing mechanism. Thence the coal gently slides down into the hopper of the weighing machine, a self-registering automatic contrivance. The coal having settled in the hopper, hydraulic pressure is turned on by the mast of the crane when turning round to bring up more coal, and the weighing machine hopper slowly rises, carrying with it a weighing beam, of which the outer end presses against a spring connected with a self-recording dial. The coal being weighed and recorded, the hopper sinks back to its foundation ready for the next charge. Two folding doors, operated by hydraulic rams, connected with the exhaust water from the crane, open and allow the coal to drop on the steel chain conveyer which takes it to the stores. As soon as the fuel has all fallen on to the conveyer the folding doors shut, and then the next charge from the grab is delivered. The conveyer is a steel chain running in a cast-iron trough, and travels up an incline from the weighing machine to the two similar conveyers running longitudinally along the coal store at a height of 12 feet from the floor; these are driven by a compound Chandler engine.



Two-Phase A.C. Generating Set.

The apparatus is capable of dealing with 35 to 40 tons



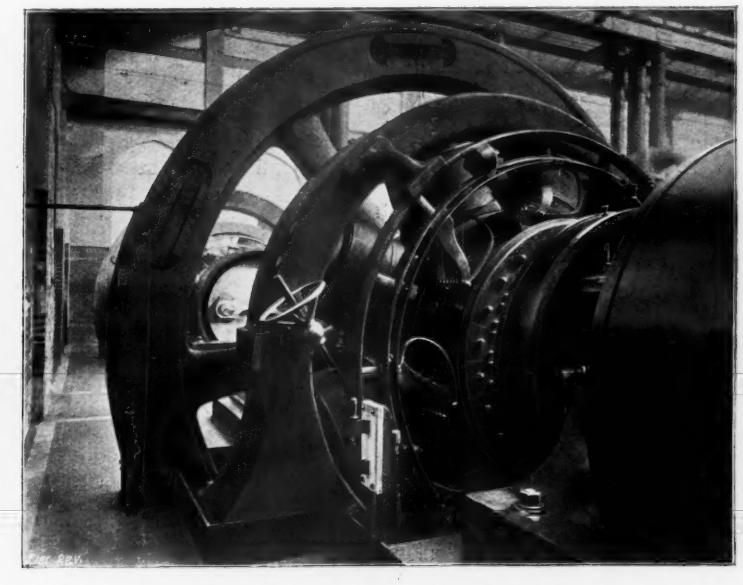
Single-Phase A.C. Sets and Motor-Generators.

means of a steam injector which, however, is found

slews round while the grab is rising, and on the grab coming

of coal per hour, and the whole of the labour required to work it consists of two labourers in the barge below to trim the coal into a heap for the grab as the barge is nearly emptied; one man to work the crane, and part of the ordinary trimmer's time in opening or closing the doors of the conveyer shoots as the bunkers are filled. Including steam, water, and labour, but not including interest or depreciation on the cost of the appliances used, the cost of handling is approximately 1d. per ton from the barge into the bunkers. The coal store, part of which is shown in one of our illustrations, is capable of containing over 1,000 tons; the coal used is "rough small Durham."

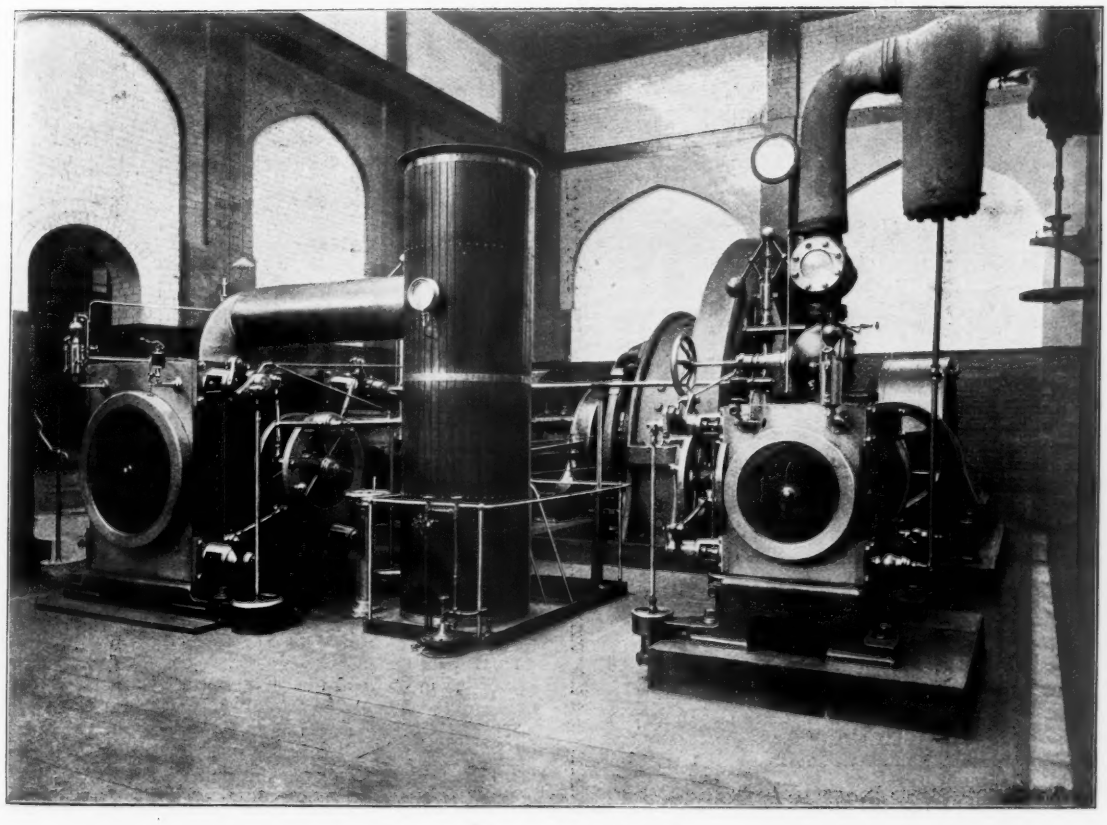
On the same floor there are two large water storage tanks, and a feed-water purifier of Doulton's make, into which water from the New River Company's mains is fed; the water, after purification, is stored in these tanks, which are connected with the feed water tanks on the pump floor below by means of a straight pipe controlled by an automatic valve, thus providing any make-up water required, and ensuring continuity of feed water supply should the engines from any cause be exhausting to atmosphere.



Direct Current Generator.

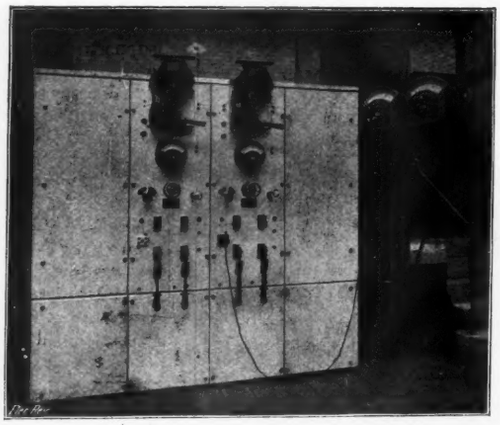
The engine room, which adjoins the boiler room, is 60 feet in width, with an average length of 180 feet, and is provided with a row of pillars along the centre, supporting the roof and the girders which carry the two 20-ton cranes. Owing to the peculiar shape of the site, it was found impossible to utilise the whole space for generating sets, and it was decided to put two landing stages on the road level, the floor of the engine room itself being at the same level as the floor of the stoke room.

On the right-hand side on entering the engine room there are two centrifugal pumps driven by steam engines, and one centrifugal pump driven by a Westinghouse motor for supplying circulating water, which is drawn from the canal at the southern end of the building, and discharged at the northern end. To the left of these pumps, and close by the landing stages, are three steam-driven exciters, two of the Electric



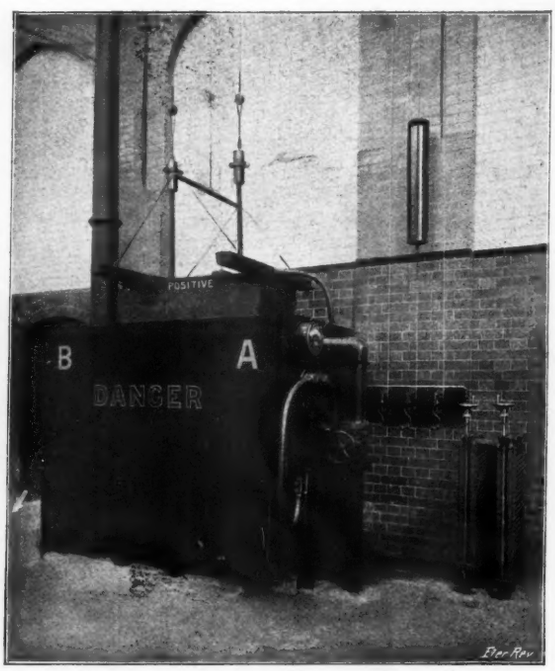
Direct Current Generating Set.

Construction Company's make, and one of the Brush Company's manufacture; the governors of the exciter engines are electrically controlled from the main switchboard. Further along on the same side, well seen in our bird's eye view, there are six 200-KW. two-phase generators, built by the Electric Construction Company, of Wolver-



D.C. Power Switchboard.

hampton, with a frequency of 50 periods per second. These are probably the first machines of this type built in England for use in this country; it is, therefore, pleasant to record that they have proved entirely satisfactory in every way. They are of the revolving field-magnet type, with fixed external armature, the winding of which is laid in slots in a laminated core. The variation in terminal pressure between no load and full (non-inductive) load, with constant speed and excitation, does not exceed 1·8 per cent., while when one phase is fully loaded and the other idle, the difference in terminal pressures is 2·4 per cent.

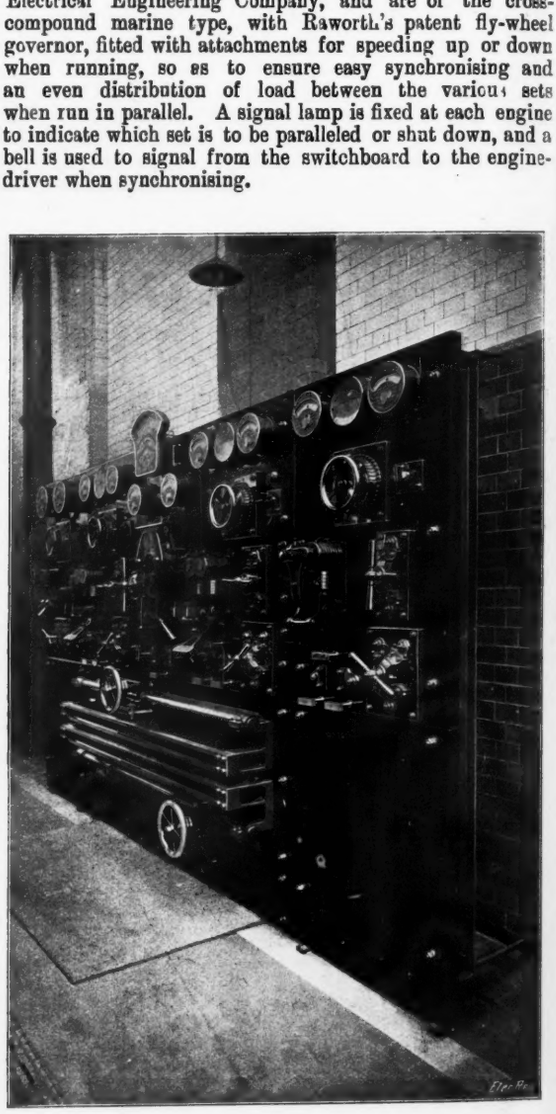


Water Resistance.

The combined overall efficiency of the combination of Brush engine and E.C.C. alternator reaches a remarkably high value, and the exciting power required is only 0·87 per cent. of the output.

The two-phase generators run absolutely without humming, being, in fact, as silent as direct-current dynamos.

On the other side of the station there are five single-phase alternators, made by the Brush Company, of Mordey's well-known pattern. These were originally supplied as 150 KW. machines, but it was found that, owing to improvements in design, they could be safely loaded to 90 amperes at 2,000 volts, the frequency being 100 periods per second. The whole of the engines for the circulating pumps, exciters, and main generators were made and supplied by the Brush Electrical Engineering Company, and are of the cross-compound marine type, with Raworth's patent fly-wheel governor, fitted with attachments for speeding up or down when running, so as to ensure easy synchronising and an even distribution of load between the various sets when run in parallel. A signal lamp is fixed at each engine to indicate which set is to be paralleled or shut down, and a bell is used to signal from the switchboard to the engine-driver when synchronising.



Exciter Switchboard.

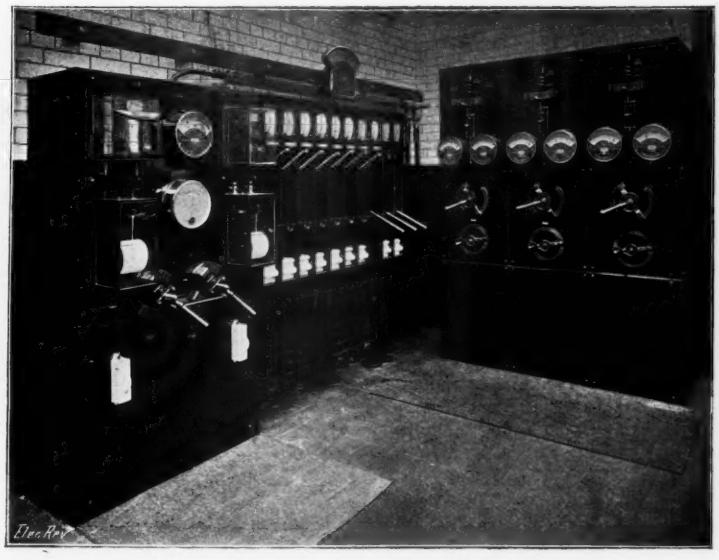
The Brush Company's machines are run in parallel with each other, and the Electric Construction Company's being of different periodicity are also run by themselves; but to ensure economy in working until all the machines are converted to two-phase machines of 50 periods per second, Mr. Lawson arranged to place a motor generator or phase-changer, made by the General Electric Company, of America, in the space between the Electric Construction Company's main generators and the exciters, the function of which is to generate either as a single-phase 2,000—2,200-volt 100-period machine, or as a two-phase 2,000—2,200-volt 50-period machine, according as a two-phase or single-phase steam generator may be at work at times of light load, thus providing for the running of one engine instead of two, while giving a single-phase supply to the older parts of the district, and a two-phase supply to the later connected districts in which mains have been laid.

At the far end of the engine room are two cross-compound

valve, thus providing any make-up water required, and

are three steam-driven exciters, two of the Electric

engines of Messrs. E. P. Allis & Co.'s make, direct coupled to 550-KW. direct current generators, also made by the General Electric Company, of America, and supplied by the British Thomson-Houston Company. These are intended for supplying power to motors in the adjoining districts, at a pressure of 550 volts, with the negative pole earthed. The circulating water for the condensers of these engines is provided by the same pumps which supply the other engines, but the condensers are separate from the engines and are fixed in the basement, with three-throw air pumps made by Messrs. Blake, Knowles & Co., and driven by G.E.C. motors. The condensed water is raised into the pipes supplying the feed tanks at the south end of the boiler room building by means of small three-throw pumps, also driven by G.E.C. motors.



DIRECT CURRENT SWITCHBOARDS.

On the switch room side of the building there are two motor generators, consisting of single-phase alternate current synchronous motors, coupled to two 75-KW. 550-volt direct current machines, which have hitherto supplied the direct current for motors throughout the Clerkenwell and St. Luke districts; there is also a two-phase 50-period synchronous motor coupled to a direct current generator of similar voltage and output. These machines, and one of the Mordey alternators, are seen in our illustration.

The steam pipes form a ring in the boiler room and a ring on each side of the central pillars in the engine room, and are cross-fed by pipes underneath the floor, so as to leave a clear way for any machinery carried by the cranes. All these pipes are fitted with section valves in the main rings, so as to have as small a length of steam pipe alive at one time as possible, and the valves for the engines are placed close up to the main steam pipe, so that in shutting down the engine the length of pipe between the main pipe and the engine is also shut off, and condensation lessened. The steam valves throughout are parallel slide ones of Messrs. Hopkinson's make.

GENERAL VIEW OF SWITCH ROOM.

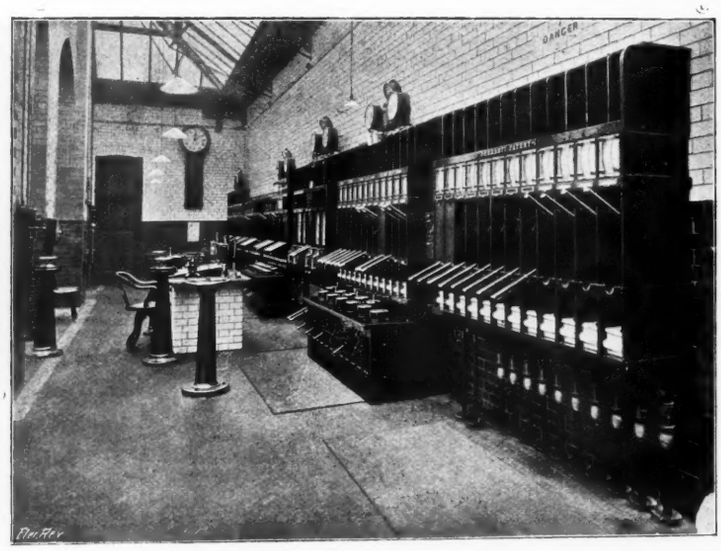
The exhaust pipes of the engines are fitted with automatic valves, so that the engines may either exhaust to atmosphere or through the condensers. The latter are combined with

the back standards of the engines driving the alternators, each engine being provided with its own air pump, driven by means of a lever off the low pressure crosshead. Although the speed of these engines is 215 revolutions per min., a fairly good vacuum is obtained. The condensed steam is returned by means of a small drum pump worked by a chain and sprocket wheel from the main shaft, it having been found that the force pumps, which were also driven along with the air pumps, ran at too high a speed to deal with the whole of the condensed water.

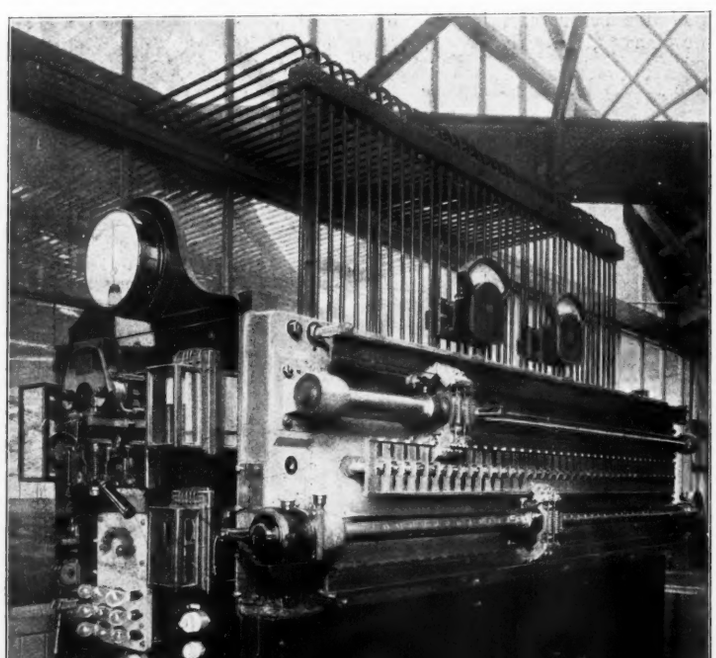
A set of Ledward ejector condensers is provided for the auxiliary and exciter engines.

For exhausting to atmosphere, a main exhaust pipe runs along underneath the floor on either side of the building to the stoke room floor, where it is joined into one main pipe, which continues to the top of the chimney, a height of some 200 feet from the ground level.

Condensing water is received from the canal in two large tanks under the roadway between the chimney and City Road. A grating is provided in an aperture of the wall leading from the canal so as to strain the water before it enters the tanks, and each tank is connected with a main pipe leading round to the centrifugal pumps, where both pipes are joined together; suitable valves are provided to shut off one length of pipe from the other. The tanks are also provided with sluices to shut off the water from the canal, so that the tanks may be periodically cleaned out. The discharge of the circulating water from the condensers is carried through to the northern end of the building, a considerable distance thus separating the intake from the outfall.



Alternating Current Switchboards and Regulating Table.



Automatic Battery-Regulating Switchboard.

The water resistance apparatus, of which we give a view, as well as an explanatory diagram, was devised in order to do away with the unsatisfactory makeshifts previously in use. It consists of a large iron tank, fitted with an inlet pipe, 4 inches diameter, connected with the circulating water mains, and an overflow to the canal. Within this is suspended a bottomless iron tank, provided with wooden fenders to steady it, and within this, again, are independently suspended two iron rods, surrounded with earthenware pipes to ensure rapid circulation. The inner tank and the rods are carried on counterbalanced tackle operated by winches. The outer tank is necessarily earthed, and forms the negative electrode when testing direct current machinery, while the inner tank is then connected with the positive pole. For testing alternators, either one or two-phase, the two tanks are coupled together and to the "outer," while the rods are connected with the insulated poles of the machine.

It is clear that this arrangement gives perfect safety to the operator, and we are informed that, by its aid, a power of 1,000 KW. can be dissipated for any length of time without appreciable rise of temperature, and with perfect steadiness and certainty. The overall dimensions do not exceed 6 feet each way. A special switchboard, with standard instruments, is about to be fitted up near the apparatus.

The overhead cranes, made by Messrs. Higginbotham and Mannock, are capable of dealing with loads up to 20 tons in weight.

Within the engine room is erected the exciter switching gear, made by Messrs. E. F. Moy & Co., for dealing with the current from the main exciters, and from the exciting

battery, which was installed in order to ensure absolute evenness of pressure. This board, which we illustrate, deals with the currents from the three main exciters, with the connections of a small exciter attached to one of the Brush machines, and with the main current to and from the exciting battery. At the other end of the building there is the switchboard for the "railway generators," of the General Electric Company of America's standard make, with panels for two more sets (should sufficient demand arise) for additional machines of the same type. For such machines space is available between the direct current machines and the present alternating current machines on both sides of the engine room. The latter switchboard is connected by cables with the power distributing switchboard, to which are also connected three switch panels made by the Electric Construction Company, of Wolverhampton, to control the direct current side of the motor generators, which may be operated either as direct current to alternating current converters, or *vice versâ*. Between the motor generator board and the feeder panels there is a main measuring board, upon which are mounted ammeters and two Thomson integrating wattmeters for light and heavy load, a recording ammeter and recording voltmeter. The feeder board consists of 10 circuit panels of Ferranti's standard pattern, originally intended for alternating current circuits, but now adapted for control of the power mains.

A new board has recently been erected for controlling two armoured cables, which will be laid along the bed of the canal to supply power to the contractors for the Great Northern and City Railway.

In a room above the landing platforms at the southern end of the building is provided a battery of 302 Tudor accumulators, having a capacity of 595 KW.-hours, which is run in parallel with the motor generators or some of the "railway" generators during the day, or by itself at night, for the supply of current to motors which may be then running in printing establishments, &c. On the same floor there is also a booster to raise the voltage sufficiently for charging, as well as a small milker for any cells which may fall "out of condition." Both these machines were supplied by the Electric Construction Company, and are controlled by switchboards made by the Edison and Swan Company.

The battery regulating switchboard, of which we give an illustration, is of exceptional interest; it is the design of Signor Enrico, and was supplied by Prof. Mengarini, of Rome, who uses similar switchboards in connection with the Rome-Tivoli installation and the distribution of current to the Roman Tramways Company.

The board consists of two rows of insulated brass blocks, for charge and discharge respectively, gripped on both sides by contact brushes, the other ends of which also grip long bars. The brushes are carried on massive steel bars, and are free to slide along, thus varying the number of cells connected. The usual resistance contact, to prevent short-circuiting of the cells, is in this case replaced by two such contacts on either side of the main brush, with graduated resistance coils, so as to reduce the spark at break.

The "charge" brush is moved by hand, as required; but the "discharge" brush is automatically set by means of the following apparatus:—

The steel bar which guides the discharge brush carrier is caused to oscillate to and fro by means of a crank driven by a small motor. Should the pressure rise or fall, a delicately adjusted relay, consisting of a solenoid in series with an adjustable resistance (partly composed of lamps) connected across the mains, sends current through one or other of two solenoids actuating a mercury switch. By this means a stronger current is set in action, causing the partial rotation of the oscillating steel bar so as to bring one or other of two rows of notches into gear with a pawl on the brush carrier; the brush is thus rapidly carried one way or the other, moving from one contact to the next one with each stroke of the bar, until the normal pressure for which the relay has been set is restored.

Three cells, corresponding with 6 volts, are cut in or out per contact; the regulating cells, 114 in number, are connected with the board by means of bare copper rods, and are on the negative (earthed) pole.

(To be continued.)

CONTRACTS CLOSED

(*Continued from page* 396.)

Croydon.—The County Council had before it the other day a report by the Lighting and Electricity Committee regarding tenders which had been received for plant for tramway purposes and for auxiliary lighting. They recommended, and the Council agreed, that the following be accepted:—Tramway plant—two compound steam engines and dynamos, the British Thomson-Houston Company, Limited; three water-tube boilers and pipe work, Messrs. Babcock and Wilcox; auxiliary lighting plant—condenser, Messrs. Allen, Son and Co.; cooling tower, the Wheeler Condenser Company, Limited.

Glasgow.—The Tramways Committee have considered the tenders for the supply of 300 car trucks and 300 car equipments (motors, controllers, &c). Having heard a report thereon by the general manager and engineer, the committee agreed to recommend the acceptance of the offer of the J. G. Brill Company, of Philadelphia, for 300 car trucks, at the price of £56 per truck; the offer of the British Westinghouse Co., Limited, London, for 200 car equipments, at £228 19s. each, and the offer of Dick, Kerr & Co., Limited, London, for 100 car equipments, at £220 each.

London.—The St. Pancras Vestry received the following tenders for the supply of condensing plant required for the Regent's Park station:—

T. Ledward & Co.	£4,594 16 6
J. Spencer & Co.	4,754 18 4
G. Wailes & Co.	5,113 16 6
Worthington Pumping Engine Company	5,974 0 0
Klein Engineering Company	5,985 0 0
John Fraser & Son (accepted)	6,909 18 0

In a report on these tenders, Mr. S. W. Baynes, electrical engineer to the Vestry, stated that those of Messrs. Ledward & Co. and Spencer & Co. did not comply with the specification as the condensers proposed were of cast-iron and the weight would be excessive for the design of the building. That offered by the Worthington Pumping Engine Company appeared to be satisfactory, but owing to the extreme height of 30 feet and the concentrated weight, it would not be possible to instal it on the roof of the station. The type submitted by the Klein Engineering Company was of a similar kind, but the company had overcome the difficulty in height and had also distributed the plant over the correct area on the roof. The company proposed, however, to use motor driven fans which the engineer considered to be an objection as the method added to the complication of the machinery. The condensers offered by Messrs. Fraser & Son and Messrs. Wailes & Co. complied with the specification, but that of the former firm afforded considerably more cooling surface, so that although the price was apparently higher, if allowance was made for the extra material put into the job and it was borne in mind that the firm would probably more than exceed the efficiency of the plant specified, the engineer considered that Messrs. Fraser & Son's tender was the most advantageous. The tender of that firm, as indicated above, has been accepted.

Newcastle-on-Tyne.—Under "Traction Notes" this week will be found some particulars of tenders accepted by the Corporation in connection with the electric tramway scheme.

FORTHCOMING EVENTS.

Friday, March 9th.—At 8 p.m. Institution of Civil Engineers, Students' paper on "The Distribution of Stress in the Walls of a Thick Cylinder," by John Duncan, B Sc. (Victoria), Stud.Inst.C.E., W. A. Wales, and G. J. Day.

At 5 p.m. Physical Society. Agenda: (1) "On the Damping of Galvanometer Needles," by Mr. M. Solomon; (2) "On the Distribution of a Gas in an Electric Field," by Mr. G. W. Walker; (3) "Exhibition of a Surface Tension Lecture Experiment," by Mr. C. E. S. Phillips.

Saturday, March 10th. — The Institution of Junior Engineers. Conversazione at the Westminster Palace Hotel. Reception at 7 p.m. by the president, the Hon. Charles A. Parsons, F.R.S., and Mrs. Parsons, the chairman, Mr. Basil H. Joy and Miss Joy.

At 11 a.m.—Institution of Electrical Engineers, Students' Section. Visit to the works of the Langdon-Davies Electric Motor Company, Limited, 101, Southwark Street, S.E.

Wednesday, March 14th.—At 7.30 p.m. Institution of Electrical Engineers (Students' Meeting). Paper on "How to Order a Steam Engine," by Mr. Seager (student).

Saturday, March 17th.—At 11.30 a.m. Institution of Electrical Engineers. Students' Visit to the works of the Electric Welding Company, 21, Hindon Street, Pimlico, S.W.

Tuesday, March 20th.—At 4.30 p.m. Society of Arts (Foreign and Colonial Section). Sir Edward A. Sassoon, Bart., M.P., "Imperial Telegraph Communication."

Wednesday, March 21st.—At 7 p.m. Institution of Civil Engineers. Annual Dinner, Merchant Taylor's Hall, Threadneedle Street.

Monday, April 23rd.—At 8 o'clock. Institution of Civil Engineers. The eighth "James Forrest" lecture, by Sir William Preece, K.C.B., on "The Application of Electricity to Engineering."

NOTES.

Mr. Medhurst's Charges.—As the Electrical Review at Mr. Medhurst's request, was the means of making it public that that gentleman had brought before the Council of the Institution of Electrical Engineers his correspondence in the matter of Tonbridge electric lighting, in which he charges Mr. Robert Hammond with unprofessional conduct; we think it is due to Mr. Hammond, and to our readers, to state that the President of the Institution has formally conveyed to Mr. Hammond an intimation to the effect that though the proceedings of the Council are private in general, yet, in view of the publicity given to the charges, it was felt that he (Mr. Hammond) was entitled to be informed that the Committee of Investigation and the Council had come to the decision that there was no cause for taking any action in the matter. Thus is disposed of, in a manner which should be satisfactory to Mr. Hammond, a charge which ought never to have been made.

Physical Society.—Among other papers read at a special meeting of this Society, held by invitation of Prof. Callendar in the physical laboratory of the University College on March 2nd, 1900 (Prof. G. Carey Foster, F.R.S., vice-president, in the chair), was one on "The Reversibility of Galvanic Cells," by Mr. T. S. Moore, was read by Dr. Lehfeldt. In these experiments the reversibility of cells, such as the Daniell and the Clark, which are assumed to be reversible, was tested by allowing the cell to send a current and by sending a current through the cells. The E.M.F.'s of the cells were determined by means of a Crompton potentiometer, and from the E.M.F.'s on open and closed circuits the internal resistances of the cells were calculated. Prof. S. P. Thompson asked if experiments had been made upon Leclanché cells, where the products of the action escape. Dr. Lehfeldt said that experiments were not made upon these cells because they were known not to be reversible. A paper on "The Damping of Galvanometer Needles," by Mr. M. Solomon, was postponed until the next meeting. The Society then adjourned until March 9th.

Wiring of Consumers' Premises.—The Poplar Board have addressed a communication to the London County Council on the subject of the wiring the premises of intending consumers, and have asked the other metropolitan local authorities to give their support. The letter, which is signed by Mr. L. Potts, is as follows:—

> This Board, in carrying out the work of developing the electricity scheme adopted for the Poplar district under the Poplar District Provisional Order of 1893, has had in contemplation the establishment of a department for the wiring of consumers' premises upon a hire or easy-payment system. It is felt this would greatly facilitate the more general adoption of electric lighting in the district by persons who would not be disposed to meet in one payment the initial cost of an installation. It appears, however, that no power exists to enable local authorities to borrow money for the purpose referred to, and as a somewhat large capital expenditure would be involved, the Board has decided that, pending the acquisition by local authorities of such power, schemes should be invited from companies or persons willing to undertake the work. I am instructed to request that the London County Council will promote legislation enabling metropolitan local authorities to borrow money for the purpose of wiring consumers' premises, and to carry out such work, and to ask the local authorities in London who supply electricity, or have applied for provisional orders, to support the action of the Board. I am, of course, aware that power will be possessed by the new Borough Councils to promote Bills in Parliament for such purposes, but, in any case, time would be saved by the London County Council undertaking the promotion of legislation.

It should be mentioned that the St. Pancras and Battersea Vestries have already decided to support Poplar, whilst the Islington Vestry have referred the question to the Electric Lighting Committee for consideration.

X Rays in Accident Claim Cases.—In a recent claim for damages against the South-Western Street Railway Company, of Philadelphia, for injuries received while travelling on one of the company's cars, a Mr. Cochran obtained a verdict of $15,000. An expert, Dr. M. K. Kassabian, showed that X rays had played an important part in the diagnosis of B. F. Cochran's injuries, which included a fractured skull and spine.

The Electrical Engineers Volunteers.—In another place we report the principal speeches which followed the "send-off" dinner to Major Crompton and his merry men. Lord Kelvin was absolutely rejuvenated, fighting his battles o'er again as he spoke lovingly of the Lanarkshire Volunteers, in which he was captain 40 years ago. Never of late years have we seen England's *doyen* of science enter more thoroughly into the spirit of anything with which he has been connected, and hosts and guests were both influenced by the enthusiasm and fervour which filled the man who has done so much to prepare the way for the duties which the Electrical Volunteers are about to put into practice. Sir W. H. Preece, if somewhat subdued, was in his happiest vein, and Major-Gen. Webber, R.E., rose to real flights of eloquence in the tender solicitude which characterised his thoughts for those who are left behind. Captain Lloyd, immensely popular with his men, spoke like the gallant soldier he is, and to some his blunt, sincere, manly utterances formed the speech of the evening. Major Crompton, too, was more than usually easy in his manner, and whether in his description of the apparatus going with the contingent, and of the duties to be performed on veldt or kopje, or in his comical allusions to the telegraphic communications which had taken place between himself and Kruger, he was equally at home. The fact that not a single member of the corps had been rejected by the "Medicine man," says something for electricity, remarked Mr. Crompton, but there is another remarkable feature about this detachment. If Major Crompton is disabled, if Captain Lloyd gets stranded on an *inaccessible* kopje, and Captains Leaf and Bain with Lieut. O'Shaughnessy lose their heads, the whole contingent would naturally go to Pott; but, paradoxical as it may seem, its efficiency would not be impaired in the least degree. Prof. Perry's toast of "The Chairman" concluded the post-prandial orations, and was delivered in his usual incisive, witty manner, the love and veneration which he bears for Lord Kelvin, his former preceptor, being apparent to everybody present. Patriotism, enthusiasm, and the best of good feeling between hosts and guests reigned supreme. Mr. T. H. Harrison sang, Mr. T. E. Gatehouse fiddled, and Mr. Edwin Rorke recited, and Saturday, March 3rd, will long live in the minds of those who were fortunate enough to participate in one of the most pleasant functions in connection with our volunteers which can well be conceived. It is only just to add that the *chef* of Princes Restaurant had prepared a charming dinner wholly worthy of the occasion; no greater compliment need we offer, nor could a more suitable "mess-room" be desired than that in which hosts and guests, whose names are appended below, foregathered:—

Hosts:—Messrs. H. Alabaster, Ll. B. Atkinson, W. W. Beaumont, S. W. Beevor, C. H. W. Biggs, T. Blisset, B. B. Blount, M. Byng, A. H. Carter. W. G. Carter, A. Colson, H. W. Cousens, W. J. Crampton, C. W. S. Crawley, H. G. E. Cross, M. C. Dent, Lieut. K. Edgcumbe, Mr. H. Edmunds, Capt. R. S. Erskine, Messrs. S. Z. de Ferranti, E. Fox, T. E. Gatehouse, J. M. Gorham, R. K. Gray, W. E. Gray, R. Hammond, H. E. Harrison, J. H. Harrison, Lieut.-Col. H. S. Hassard, Messrs. W. C. Hawtayne, M. Heaphy, Hedley, H. Hirst, A. Hodgson, Capt. B. Hopkinson, Mr. A. H. Howard, Lord Kelvin, Mr. H. R. Kempe, Dr. A. B. W. Kennedy, Messrs. A. J. Lawson, H. Lee, E. H. Leaf, W. G. McMillan, W. M. Madden, W. L. Madgen, E. Manville, C. P. Martin, Moore, W. M. Mordey, Dr A. Muirhead, Major S. Flood Page, Mr. J. B. Peace, Lieut. J. E. Pearce, Prof. J. Perry, Mr. E. J. Piper, Mr. G. A. Poynton, Mr. G. L. Preece, Sir W. H. Preece, Messrs. H. Reason, F. R. Reeves, F. E. Randle, T. E. Rich, T. J. Rorke, A. W. Sclater, S. Sharp, J. N. Shoolbred, A. Siemens, C. H. Stearn, A. S. Suckling Baron, J. W. Swan, J. Swinburne, A. A. C. Swinton, E. Talbot, H. A. Taylor, A. P. Trotter, Capt. Underwood, Prof. W. C. Unwin, Capt. R. Wallis-Jones, and Maj.-Gen. Webber, C.E., C.B.

Guests (Active-Service Contingent):—Major R. E. B. Crompton, Capt. F. L. Lloyd, R.E., Capt. A. Bain, Capt. H. M. Leaf, Lieut. J. J. F. O'Shaughnessy, Lieut. A. H. Pott, Second-Lieut. J. H. Stabbs, Sergt.-Major Brown, R.E., Sergt. Ruse, R.E., Sergt. H. S. Phillips, Sergt. W. S. Entwistle, Sergt. T. H. Brown, Sergt. A. Charlton, Corpl. H. F. Biggs, Corpl. H. H. Bicker-Caarten, Corpl. F. W. Dalton, Corpl. J. H. Stone, Second-Corpl. A. H. J. Graham, Second-Corpl. J. P. Williams, Sappers S. W. Melsom, R. W. Holliday, J. M. Bowey, G. F. H. Elliott, F. C. Weakley, J. Rook, D. F. Colson, G. Charlton, E. C. Short, F. J. Wallis, A. Devonshire, C. Landon, W. H. Hossack, C. F. Love, R. H. Brander, H. R. Allen, M. N. Crawford, H. A. Paris, F. J. Young, C. E. Silverthorne, H. Bertram, E. J. Wright, H. B. Tilley, A. J. Hodgson, E. J. West, L. H. Hounsfield, F. J. Phillips, E. C. Horsley, N. W. Pirrie, F. C. Stephens, C. H. R. Thorn, A. R. Peart, R. B. Roberts, A. E. Levin, D. G. W. Hume, W. C. Cooke; also Capt. D. Brady, R.E., Adjutant, Dr. Bateman, Surg.-Major Stephenson, hon. medical officers.

Infirmary Lighting.—On Monday last those interested in the new Infirmary at Bethnal Green assembled in great numbers to celebrate the formal opening of the buildings. What chiefly concerns us in connection with the affair is the electrical installation, which forms a very important part of the scheme. It has involved an expenditure of between £6,000 and £7,000, and from what we saw of it we should imagine that the electrical work is as up-to-date and interesting as that of any infirmary installation in London. The lighting of the buildings is effected by about 1,200 incandescent lamps at present, but there is a plant capacity of 2,000 lamps. The present supply is also employed for driving a 40 H.P. motor for laundry purposes. The installation, for which Messrs. Owen Lucas & Pyke have acted as consulting engineers, comprises three Galloway boilers, each 30 feet × 7 feet 6 inches at 80 lbs. pressure (registered 250 H.P.) Two of these are now in regular service, the third being used as reserve. There are two Willans-Crompton steam dynamos giving 600 amperes at 100 volts normal (or about 130 volts for charging purposes); also a battery of 108 E.P.S. K type cells. The lighting is done on the three-wire system, and late at night when the whole of the lights are not in use it is arranged that the surplus current generated shall be employed charging the batteries. We may mention that at the time of our visit when the installation was in full working for the edification of the visitors, a 40-H.P. Laurence and Scott enclosed motor was driving, by 9-inch belts and shafting, as many as a dozen machines, these including two large hydro-extractors, two small hydro-extractors, three mangling machines, and four rotary washing machines. The speeds at which these various machines fulfil their ordinary work vary very widely; for instance, the mangling machines work at eight revolutions per minute, the washing machines at 400 revolutions, and the hydro-extractors at 1,500 revolutions, therefore the gearing arrangements to provide for these different speeds required careful attention. The whole of the plant, all of which is in duplicate, was carried out under one contract by Messrs. Calvert & Co., of Manchester, this firm being responsible for the wiring of the buildings, the switchboard, &c., and Messrs. Z. D. Berry & Co., of Westminster, furnishing the laundry machinery, ventilating, and certain other arrangements, under the supervision of the firm of consultants mentioned above. Mr. G. F. Broadley has charge of the work as electrical engineer to the Infirmary authorities.

Adjustment of Electric Lighting Areas.—In connection with those metropolitan Vestries which are undertakers under the Electric Lighting Acts, the Board of Trade have had under consideration the variations of the existing boundaries between London parishes which have been settled by the Commissioners appointed under the London Government Act, 1899. It appears to the Board that the boundaries of the areas of electric supply of the different districts affected should, if possible, be adjusted to coincide with the boundaries settled by the Commissioners. With this object in view, a preliminary conference was recently held at the offices of the Board of Trade under the presidency of the Hon. Thomas H. W. Pelham, when representatives were present from the Hampstead Vestry, the St. Pancras Vestry, and the Metropolitan Electric Supply Company. After an exchange of views on the subject, the meeting was adjourned for the several authorities interested to endeavour to draw up terms and conditions under which the exchange of areas should be adjusted. In the meantime, the Board of Trade has arranged for a more general conference to discuss the whole question, the authorities invited including the Vestries of St. Pancras, Islington, Shoreditch, Hackney, Stoke Newington, Clerkenwell, and St. Luke, Middlesex.

Lectures.—On 28th ult. a lecture was delivered before the Royal Dublin Society by Prof. Fitzgerald, F.R.S., the subject being "The Development of Electric Light."

On March 1st Prof. Silvanus Thompson lectured at the London Institution on "Electric Locomotion."

Obituary.—We hear with regret of the death of Mr. H. Gardner, the well-known patent agent of Fleet Street, E.C.

The Ignition of Firedamp and Coal Dust by Electricity.—In the course of a discussion which recently followed the reading of a paper by Bergassessor Heise and Dr. Thiem on "Experiments on the Ignition of Firedamp and Coal-dust by Means of Electricity," Mr. A. L. Steavenson said he thought the paper showed very clearly that the conditions under which it was safe to employ electricity were rare indeed. In the precautions to be observed, it was pointed out that the experiments were not made with the object nor were they capable of formulating a definite opinion as to the applicability of electricity in fiery mines, and it was stated that "in brief the sum of the results obtained shows that in general the amount of electrical energy which is capable under certain circumstances of igniting firedamp need only be extremely small." It appeared to him (Mr. Steavenson) that whether it was extremely small or extremely great, it was not very desirable to have it. The individual results were summarised in the paper as follows :—

2-C.P. lamps for 6 volts and 0·80 ampere—unsafe.					
10	"	65	"	0·46	" safe.
16	"	65	"	0·77	" unsafe.
16	"	100	"	0·50	" safe.
16	"	150	"	0·33	" safe.
25	"	110	"	0·73	" unsafe.
25	"	150	"	0·58	" safe.
25	"	220	"	0·38	" safe.
35	"	100	"	1·00	" unsafe.
50	"	100	"	1·50	" unsafe.
100	"	100	"	3·00	" unsafe.

If the margin between what was safe and unsafe was so small that they could not take a 10-C.P. lamp with 65 volts and consider themselves safe—and it was shown that with 15-C.P. and 65 volts they were unsafe—he thought all they had proved was that it was neither safe nor pleasant to introduce electricity into a fiery atmosphere. The President said the experiments seemed to prove that anything above half an ampere was unsafe.

Appointments Vacant.—The Plumstead Vestry wants an assistant electrical engineer to help in the preparation of drawings for the construction of electricity supply works. A telegraph linesman is wanted for the telegraph department at Northern Nigeria at £200 per annum. An assistant electrical engineer is wanted for the Bexhill electricity works at £125 per annum. For particulars of these appointments see our "Official Notices" to-day.

The Fire at the Grand Theatre.—A committee of the L.C.C., reporting upon the recent fire at the Grand Theatre, Islington, said that "Gas battens were evidently a source of danger, inasmuch as they allowed of careless manipulation, and the committee were of opinion that where a theatre was partially lit by electricity that agent should be used for all stage lighting."

Metropolitan Electric Supply Company.—On the invitation of the directors, a large party of visitors, including many distinguished electrical engineers, inspected the company's new station at Willesden on Thursday last week. Particulars of the generating sets, switchboards, &c., have already been given in our issues of February 16th, 1900, and September 23rd, 1898; further details will be given at an early date.

Polarised Light.—On Saturday afternoon last at the Royal Institution, Lord Rayleigh delivered the first of a course of lectures on the "Polarisation of Light."

Lord Rayleigh will not deliver the second of his course of lectures on Saturday afternoon next, owing to the sudden death of his mother, the Dowager Lady Rayleigh.

The Royal Society.—Yesterday afternoon the Bakerian lecture on "The Specific Heat of Metals and the Relation of Specific Heat to Atomic Weight," was delivered by Prof. W. A. Tilden, F.R.S.

NEW COMPANIES REGISTERED.

Tramways and Light Railways Estates Company, Limited (65,201).—This company was registered on February 28th, with a capital of £100,000 in £1 shares, to acquire and deal with any lands, buildings, estates and property, and to carry on the business of builders, planters, farmers, proprietors of piers, boats and ferries (whether working in connection with railways or tramways or not), wharves, works and conveniences, &c. The first subscribers (each with one share) are:—E. Garcke, Donington House, Norfolk Street, W.C., managing director British Electric Traction Company, Limited; S. Morse, 37, Norfolk Street, W.C., solicitor; G. Stevens, Donington House, Norfolk Street, W.C., secretary British Electric Traction Company, Limited; T. Vickers, Donington House, Norfolk Street, surveyor; C. H. Dade, Donington House, Norfolk Street, assistant secretary British Electric Traction Company, Limited; E. Hopwood, Donington House, Norfolk Street, W.C., secretary to a public company; and G. J. Somerville, Surrey House, Victoria Embankment, W.C., electrical engineer. The number of directors is not to be less than three nor more than six; the subscribers are to appoint the first; qualification, £250; remuneration, £50 each per annum and a share in the profits (maximum, £2,500 per annum, divisible). Registered office, Oswaldestre House, Norfolk Street, W C.

National Gas Engine Company (1900) Limited (65,168.)—This company was registered on February 24th, with a capital of £200,000 in £1 shares (100,000 5½ per cent. cumulative preference), to acquire the business now carried on at Ashton-under-Lyne, in the county of Lancaster, by the National Gas Engine Company, Limited, to adopt agreements (1) with the said old company, (2) with Herbert N. Bickerton, and (3) with Henry W. Bradley, to carry on the business of gas and oil engine manufacturers, electrical plant manufacturers, gas works plant manufacturers, mechanical, electrical, and hydraulic engineers, manufacturers of machinery, tools, boilers, stoves, tubes, and fire extinguishers or sprinklers, iron and brass founders, metal workers, electricians, iron and steel converters, chemists, smiths, wood workers, &c. The first subscribers (each with one share) are:—Henry Prescott, Hamburg Terrace, Stretford, engineer; Henry W. Bradley, Wellington Works, Ashton-under-Lyne, engineer; Henry N. Bickerton, Wellington Works, Ashton-under-Lyne, engineer; Walter Scholes, Wellington Works, Ashton-under-Lyne, secretary; Francis H. Orme, One Oak, Alderley Edge, Lancashire, gas engineer; William A. Wilkinson, Manchester Road, Ashton-under-Lyne, solicitor; and Frank Halsall, 45, Spring Gardens, Manchester, chartered accountant. The number of directors is not to be less than four nor more than seven; the first are Henry N. Bickerton and Henry W. Bradley (managing directors), Henry Prescott, Francis H. Orme, and Joseph Bickerton; qualification, £1,000; remuneration as fixed by the company. Registered office, Wellington Works, Ashton-under-Lyne, Lancs.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Renewable Electric Lamp Company, Limited (63,144).—This company's annual return was filed on February 3rd, when 30,000 preference and 100,000 ordinary shares had been taken up out of a nominal capital of £150,000 in 100,000 ordinary and 50,000 preference shares of £1 each. 5s. per share has been called up on all the preference, and 7s. 6d. per share on 1,074 ordinary shares, resulting in the receipt of £7,740 5s. £162 10s. remains unpaid. 98,926 ordinary shares are considered as fully paid.

Automatic Telephone Company, Limited (55,157).—This company's annual return was filed on February 15th, when 314,326 shares had been taken up out of a nominal capital of £100,000 in 400,000 shares of 5s. each; 5s. per share has been called up on 17,620 and 3s. per share on 26,410; £7,897 0s. 4d. has been paid (including £156 13s. 4d. in advance of calls) leaving £626 3s. in arrears; 270,296 shares are considered as fully paid.

Peru Telephone Company, Limited (29,920).—This company's annual return was filed on January 17th, when seven shares had been taken up out of a nominal capital of £100,000 in 20,000 shares of £5 each. No calls.

Direct United States Cable Company, Limited (11,587).—This company's annual return was filed on February 16th, when 60,710 shares had been taken up out of a nominal capital of £1,300,000 in 65,000 shares of £20 each. All the shares are considered as fully paid.

A. E. Gwynn, Limited (63,799).—This company's annual return was filed on February 16th, when the entire capital of £500, in £1 shares, was taken up and paid in full.

Weymouth Electric Light and Power Company, Limited (53,120).—This company's annual return was filed on January 13th, when seven shares were taken up out of a nominal capital of £10,000 in 2,000 £5 shares. No calls have been made.

Headland's Patent Electric Storage Battery Company, Limited (45,524).—This company's annual return was filed on January 19th, when the entire capital of £20,000 in £1 shares had been taken up. £1 per share has been called up on 5,007, and £4,982 has been received, leaving £25 in arrears. £14,993 is considered as paid on the remainder.

SUPPLY STATION ACCOUNTS.

Blackpool Corporation Electricity Accounts.

The accounts of the electricity undertaking of the Blackpool Corporation indicate a continuance of the period of growth and development. The extensions in hand in March, 1898, were estimated to cost £40,000, and the further extensions proposed were estimated at a similar sum. The capital expended was then £84,000, and this rose to £102,000 12 months later. The units sold are distributed over private lighting, public lighting, and tramway traction as follows:—

1898.

Private	...	523,412 at 8d., 5d., 2½d., and 2d. per unit.
Public	...	164,922 at 8d. and 2d. per unit.
Tramways	...	181,850 at 2d. per unit.
Generated	...	1,098,603.

The public lighting is represented by 146 arc lamps, while the private consumers number 694. The total capacity of plant installed is 1,350 KW.

General Statement.

	1897.	1898.	Increase.
Total capital expenditure ...	£84,000	£102,002	£18,002
Number of units sold ...	707,965	870,184	162,219
Number of lamps connected	58,000	60,200	2,200
Maximum load in kilowatts...	900	950	50
Gross revenue	£12,827	£14,284	£1,457
Gross profit	£5,675	£7,122	£1,447
Average price per unit sold...	4·191.	3·91d.	−·28d.

The revenue account shows an increase of nearly £2,000 in the item for sale of current, but the price per unit has fallen from nearly 4½d. to just over 3 9/10d., a reduction of over ¼d. As the other items of revenue have also fallen both in the gross and per unit, the total reduction in revenue per unit works out at over ·4d. That the average return should be only 3·94d. is a sufficient answer to those local busybodies who some time ago criticised adversely Mr. Quin's adoption of the demand indicator principle.

Revenue Statement.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Sale of current	£12,352	4·19d.	£14,165	3·91d.	−·28d.
Meter rents	279	·09d.	...	...	−·09d.
Supply of lamps, &c. ..	...	...	...	...	...
Sundry fees, &c.	196	·07d.	119	·03d.	−·04d.
Gross revenue ...	£12,627	4·35d.	£14,284	3·94d.	−·41d.

The costs of production are decidedly good. With works' cost only a little over 1½d. (a reduction of over ½d. on 1897) and total costs of under 2d., the borough electrical and tramways engineer should be well satisfied. No doubt the traction load has assisted materially.

Cost of Production.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase
Coal	£2,586	·88d.	£2,011	·55d.	−·33d.
Oil, waste, water, and engine room stores.	787	·27d.	788	·22d.	−·05d.
Salaries and wages incurred in generation and distribution.	1,493	·50d.	1,614	·45d.	−·05d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,121	·38d.	1,092	·30d.	−·08d.
Works' costs	£5,987	2·03d.	£5,505	1·52d.	−·51d.
Rent, rates, and taxes ..	254	·08d.	339	·09d.	+·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	739	·25d.	928	·26d.	+·01d.
General establishment charges, stationery and printing, law charges and insurance.	172	·06d.	365	·10d.	+·04d.
Other expenses	...	...	25	·01d.	+·01d.
Total costs ...	£7,152	2·42d.	£7,162	1·98d.	−·44d.

The interest and sinking fund charges have increased by nearly £700. Yet notwithstanding this the net profit has risen over £770.

Profit Statement.

	1897.	1898.
Interest on loans	£3,856	£2,605
Sinking fund for repayments	...	1,940
Net profit carried forward	1,819	2,577
Gross profit	£5,675	£7,122

CITY NOTES.

Amazon Telegraph Company, Limited.

For some reason or other the representative of the Electrical Review was refused admission to the meeting of this company, which was held at Moorgate Station Chambers last Friday. He presented himself in the usual way, yet not only was he refused admission to the meeting, but a copy of the directors' report was withheld from him, while it was specially handed to the representative of an esteemed electrical contemporary. We think, however, our readers would not like to be altogether out of touch with so profitable an enterprise, and we accordingly reprint the following report of the proceedings from the *Times* of Saturday last:—

"Mr. D. H Goodsall presided in the absence through indisposition of Mr. W. S. Andrews.

"The Chairman, in moving the adoption of the report, stated that it showed the result of the year's working, and, owing to the difficulties which had been experienced in maintaining the cables, a debit balance of £29,000 was shown. The traffic existed, and if the cables could have been kept working the accounts would have presented a very different appearance. An excellent captain was now engaged on repairing the cables, and he had met with considerable success. In three places the lines had been diverted, and it was hoped that this change would lead to the permanent maintenance of these parts of the system. Similar diversions would be made wherever it was seen that the cable would not last in its present position. The directors had succeeded in obtaining from the Government of the State of Amazonas a concession for a land line, which they hoped shortly to be able to erect. The Government had nearly completed the road which they undertook to make for this line, and the directors had already despatched more than one-third of the requisite material, while the remainder had been ordered. A further subsidy of £10,000 a year would be received by the company when the land line had been put up, so long as it was kept in working order, and the line would also duplicate a part of the system.

"Mr. John Coppen seconded the motion.

"The Chairman, in answer to questions, stated that if the undertaking could be kept at work—and the directors felt that the only course for them was to do their utmost to ensure this—the company would earn £27,000 a year in subsidies, in addition to which a good traffic existed. Part of the system, although, unfortunately, not a very profitable part, had remained in working order throughout nearly the whole period of four years during which the cable had been in operation, and on this portion an increase of about 85 per cent. in the traffic had been shown.

"The motion was unanimously adopted."

Chelsea Electricity Supply Company.

The annual ordinary general meeting of the shareholders of this company was held on Wednesday at the Chelsea Town Hall. Mr. J. Irving Courtenay, the chairman, presiding.

In proposing the adoption of the report, the Chairman said: The dividend of 6 per cent. on the ordinary shares had been maintained, although the capital was increased at the end of 1898 by a debenture stock issue of £40,000. Owing to the state of the money market last October, it was deemed advisable to make an issue of debenture stock rather than shares, and £50,000 was issued to meet the necessary capital expenditure. The issue was largely over-subscribed. In regard to the capital expenditure, they were now approaching a period when that expenditure in some directions would be appreciably less, and there would be an increasing return on the capital already expended. It was a pleasure to him to say that they had never yet been wanting in their supply, and no one could point to any case of failure or refusal to supply, or of inefficient supply on the part of the Chelsea company. As to the encouraging prospects in the immediate future, first he might draw their attention to the fact that the cost of the unit is decreasing in all its items, the total cost being nearly ½d. less than in 1898, and the proportion of costs to revenue being 42½ per cent. as against 48 per cent. for 1898. Another direction in which they might look for improvement was in the increase of custom, and the generally increased use of the light by all the consumers, which would be the certain result of the reduction in price by the introduction of the maximum demand system of charging for current supplied. That system, which had been most successful at Brighton and other towns, had the effect of encouraging the use of the light for long hours by giving the long-hour consumer, though he might have only a few lamps, a distinct advantage in price over the consumer who might use large quantities for a short time only. By that means the plant was employed for longer hours, and thus earned a larger return on capital expenditure. The system was introduced in October last, and they could not expect to get the benefit of it until it became widely known. They had sent circulars to about 7,000 residents in Chelsea showing, by actual results, the benefit obtained by the consumers, and that should within the next 12 or 18 months bring an increase not only in the number of lamps but in the revenue per lamp. They had also published the fact that they were prepared to wire premises on the purchase-hire system. They had to be prepared to meet some disadvantageous elements. There was, of course, the reduction in price which would be, however, compensated for in a short time by increased use of the light. A sum somewhat in excess of that provided in 1898 had been placed to renewals and depreciation fund, in view of the increase in capital expenditure. Some shareholders indeed would like to see larger amounts provided for depreciation. The necessity for those provisions was so obvious, that he would not draw pointed attention to them, were it not that certain holders of founders' shares seemed to be of opinion that they were being hardly used. They had had interviews with Mr. Henry Kimber and other gentlemen who represented some of the holders of the founders' shares, and though these conferences had been of a most friendly character, still they were not in accord upon the subject of the rights attaching to the holders of the founders' shares. He could only say that if those shareholders would carefully examine the accounts, they would see that up to the present there had been no margin of profit available for division among them. They had completed the large generating station at Alpha Place, and were putting in the remainder of the plant. That station would have a capacity for serving a total lamp connection of 150,000. Additions had also been made to the workshops; those were well equipped, and had been of great assistance in carrying out efficiently and with proper economy the necessary constructional and repairing work for the company's stations. A new storage and distributing station had been erected on freehold land at Carlyle Square. That had been equipped, and was now at work. One more sub-station was being erected in Milner Street, and that would complete the sub-stations required for serving the district. Important extensions of the mains had been carried out to meet the increasing demand for a supply in various parts of the parish. The number of lamps added during the year was 16,280, which was slightly more than in the previous year. The principal saving effected was in the coal, and under that head there had been a saving of about one-fourth of a penny per unit. That result had been obtained partly in consequence of the very careful supervision which had been maintained to prevent waste of fuel, and partly in consequence of the attention given to rendering more perfect the coal saving appliances. That saving of fuel was particularly important in view of the abnormal increase which had taken place in the price of coal. There were few large business undertakings which had not temporarily lost the services of some of their employés who have gone to South Africa. In the case of that company, several of their men had been called up to join the Reserves, and the company was contributing towards the maintenance of the wives and families, feeling sure of the support of the shareholders in that course.

Major-General Webber, C.B., seconded the resolution, and pointed out that the company was in a much better position than many other concerns inasmuch as they had provided land and buildings which would suffice for all their requirements as long as their provisional order ran.

Mr. Dawe raised the question of the position of the founders' shares, and asked what course the directors intended to pursue in the future in regard to those shares. He took it that they ought to have had one-third of the profits after the ordinary shares received their 6 per cent. He moved as an amendment:—"That the amount of £1,096 8s. 5d. be not placed to a coal reserve fund, but be added to the year's net revenue, and divided in accordance with the articles of association between the holders of the ordinary and founders' shares."

Mr. Makin seconded this.

The Chairman, in reply, said that the board had no predilection one way or the other in the matter of the founders' shares, because they held both classes of shares. All they desired, as prudent men, was to do the best for the company as a whole, and their object was to create a good reserve fund to put the company into a strong position.

After further discussion the amendment was withdrawn and the report was adopted.

The Hove Electric Lighting Company, Limited.

The annual meeting of this company was held on Wednesday at Cannon Street Hotel.

Col. A. J. Filgate, R.E., who presided, moved the adoption of the report, which has already been printed in the Electrical Review. He said that the capital expenditure during 1899 amounted to £16,210, making the total £93,860. The generating station had been increased to the full extent to which the Hove Corporation would allow on the present site. Two new Crompton-Willans sets of 350 H.P. and 250 H.P., and a spare armature, had been added, at a cost of £5,420, this increasing the capacity to 1,690 H.P. A new Babcock boiler had been erected, and a further 1½ miles of new mains and feeders laid, increasing the length to 15¾ miles. New meters and demand indicators had cost £1,255. They had to deal with an expanding business, and must be prepared to meet customers' requirements. They had ordered another 250 H.P. steam dynamo for delivery in the autumn. When this was erected, the station would be full up, and they would be able to meet next winter's anticipated demand. For further increase they contemplated erecting a new station, but some difficulty had arisen with the Corporation as to the site, and as soon as that was settled they would take up the work. They believed that the outlay would prove remunerative. The business had been steadily progressing. For 1899 they sold 94 000 more units than for 1898, and for the first nine weeks of 1900 the units sold were 127,655, an increase of 24,106 over 1899. The reduction in the price had helped to swell the consumption, and to increase the profit. They commenced 3½ years ago to supply new customers at 200 volts instead of 110 volts, and at the present time they had more customers at the higher than at the lower voltage. Customers who agreed to take supply at 200 volts were charged 7d. per unit, and others 8d. as hitherto. The new issue of shares was promptly taken up by shareholders, and the premium had been placed to reserve. They would have to issue more capital this year for further mains, the new dynamo, and partly for the new station. The revenue account showed the number of houses last year as 671, compared with 513 in 1898. The lamps and motors attached to the

system reached 44,824 8-c.p., against 36,967 at the end of 1898. Units sold were 444,499, against 350,254 in 1898; gross revenue, 1899, £12,070; 1898, £9,480; increase, £2,590; working expenses £4,973 in 1899, against £4,390 in 1898, an increase of only £583. The result was a net revenue of £7,097 as compared with £5,090, an increase of £2,007. The gross revenue per 8-c.p. lamp was only 5s. 7d., so that the result was exceedingly satisfactory. Since the issue of the report they had had a slight accident at the works. The armature of one of the 350-h.p. steam dynamos burnt out on February 26th, and this resulted in a failure of supply for five minutes. Special meetings will be called to alter the articles in order to meet the Stock Exchange requirements. The chairman paid a tribute to the work done by Mr. Smith, the engineer at the works, and by Mr. Reeves, the secretary. The future looked prosperous.

Colonel Wood seconded the motion, which was carried unanimously, also a resolution declaring 9 per cent. per annum for the last half of 1899, making 7½ per cent. for the year against 6½ in 1898.

Davis & Timmins, Limited.

The directors' first annual report to be submitted to the meeting on Wednesday, March 14th, at Winchester House, at 2.30 p.m., reads:—

The net profit for the whole year, after allowing for depreciation, is £9,400 17s. 4d. Out of this the sum of £2,240 15s. 1d. has been apportioned as profit made previous to the formation of the company, and therefore not available for dividend. From this sum interest on purchase-money paid to vendors and stamp duties, amounting together to £786 14s. 1d., has been deducted, and the balance of £1,454 1s. placed to capital account. Of the available balance of £7,160 2s. 3d., the interim dividend paid in September last on the preference shares absorbed £773 0s. 7d., leaving a balance of £6,387 1s. 8d., which the directors propose to employ as follows:—

To the payment of six months' interest on the preference shares to December 31st, 1899	£1,780	4	9
To the payment of a dividend for the period ending December 31st, 1899, on the ordinary shares at the rate of 8 per cent. per annum	2,810	19	2
To commissions to managers as per agreements	275	0	0
To be carried forward	1,520	17	9
	£6,387	1	8

Subject to the approval by the general meeting of the recommendations as to dividends, the warrants for both the preference and ordinary dividends will be posted to the shareholders on the 15th inst., and be payable on the following day. The directors are pleased to say that the building of the new factory at Wood Green is approaching completion, and the necessary machinery is now being delivered, the erection of the latter will be taken in hand as soon as the building is handed over to the company. The plant and buildings at York Road, King's Cross, have been maintained in a thoroughly efficient state, and the directors consider the business outlook for the coming year as most satisfactory.

Prospectuses.

There have been several prospectuses of electrical interest before the investing public this week. These include that of the National Gas Engine Company (1900), which has been formed with a capital of £200,000, divided into equal proportions of 5½ per cent. cumulative preference and ordinary shares of £1 each, to take over and extend the business of the National Gas Engine Company, Limited, at Wellington Works, Ashton-under-Lyne. The vendor company takes the whole of the ordinary shares in part payment of the purchase price of £103,500, the remaining £3,500 being payable in cash or preference shares. A further 16,000 of the preference shares will be allotted to the debenture holders of the vendor company in exchange for their debentures, and the remaining 83,993 shares are now offered for subscription. With the additional working capital of £75,500 provided by the present issue, it is now proposed to still further extend the business, and also to place on the market an oil engine of which the company holds the patents. The profits are stated to have been £4,871 in 1897, £9,375 in 1898, and £13,106 for the 11 months to December last. The list closed on Wednesday.

The National Telephone Company has been inviting subscriptions until yesterday (Thursday) for an issue of 100,000 ordinary shares of £5 each at par and £500,000 4 per cent. debenture stock at the price of 98 per cent. The shares offered for subscription are part of an authorised issue of 890,000 such shares, of which 490,000 have already been taken up and paid in full. The debenture stock may be redeemed on or at any time after December 31st, 1904, at 105 per cent.

The Electric and General Investment Company is offering, until 4 p.m. to-day (Friday), for subscription an issue by the Bournemouth and Poole Electricity Supply Company, Limited, of £70,000 4½ per cent. debenture stock, offered at the price of 103 per cent. The company, which has a share capital of £150,000 in £10 shares, preference and ordinary, all of which has been subscribed and called up, bought over all the interests held by the County of London and Brush Provincial Electric Company in the Bournemouth and District Electric Supply Company, Limited. The whole of the assets in the latter company are now vested in the Bournemouth and Poole Company, which has also acquired from the County of London Company all its interests in the Richmond (Surrey) Electric Light and Power Company. The assets of the Bournemouth and Poole Company are put at an aggregate of £221,250. The company also holds various provisional orders. The net revenue of the two undertakings is stated to have amounted last year to £11,792, and for 1900 it is estimated at between £13,000 and £14,000.

Notting Hill Electric Lighting Company, Limited.

The thirteenth ordinary general meeting of this company was held on Tuesday last at the company's offices, 140, High Street, Notting Hill Gate.

The chair was taken by Sir William Crookes, F.R.S., who stated that during the year ending December 31st last the progress of the company's business had eclipsed all previous records. The net profit last year amounted to £10,360 17s. 4d. as against £7,251 13s. 7d. in the preceding year, and the units sold showed an increase of 209,258, or nearly 50 per cent. The cost of generation had decreased, and was now, having regard to the size of the undertaking, the lowest in London; a system of bonuses to employés was in force. The company's Bill, by which power is given to enable the company, together with the Kensington and Knightsbridge company, to erect and work a joint station, received the Royal assent on July 13th last. The new works will be situated at Wood Lane, Hammersmith; contracts for the buildings and machinery are already placed, and it was hoped the works would be ready this year. The present station being full of machinery, and loaded to its utmost capacity, the directors had decided to refuse all new connections until a supply from the new station was available. The Bill also gave power to purchase a site in the northern part of the company's area, on which a distributing station would be erected; the machinery was already on order. Another sub-station was required near the south-western boundary of their area. Current would be transmitted at high pressure from the joint works to these sub-stations by means of a separate main. For these purposes it would be necessary to raise additional capital, the amount required being estimated at £30,000. The authorised capital at present unissued amounted to £19,000 debentures; a special meeting would be called to create new capital if necessary. In the meantime the bankers had advanced £5,000 on the joint security of the two companies. The chairman expressed the regret of the directors at the death of their colleague, Mr. Francis Radford. Mr. Swan had been elected in his place. The directors recommended a dividend of 4 per cent. per annum on the ordinary and preference shares, making with the interim dividend of 3 per cent. paid on July 1st, 1899, a total of 7 per cent. for the year, while the founders' shares receive £1 16s. each. The chairman then moved the adoption of the report, which was seconded by Mr. J. T. Jervis.

After several questions had been answered by Mr. A. E. Franklin, the motion was agreed to unanimously.

The directors retiring by rotation, Messrs. A. E. Franklin and J. T. Jervis, were unanimously re-elected, as were also the auditors, Messrs. Fox, Sissons & Co. The proceedings then terminated with a vote of thanks to the chairman.

The Metropolitan Electric Supply Company, Limited.

The directors' report to be presented to the meeting on Tuesday next, March 13th, at 12 noon at Winchester House, reads as follows:—

"The directors submit a statement of the company's accounts for the year ending December 31st, 1899, prepared in the form prescribed by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888. The capital expenditure, which at the end of 1898 amounted to £993,761 13s. 9d., has now reached a total of £1,244,254 1s. 6d., being an increase during the year of £250,492 7s. 9d., the result being an excess of expenditure over receipts of £18,977 12s. 7d. The principal item of expenditure was for the new works at Willesden. A portion of this capital expenditure was provided for by the issue of £125,000, being half of a new 3½ per cent. mortgage debenture stock which the directors considered it expedient to create. This issue was offered to the shareholders at 97 per cent. and the whole of it placed at that price. The gross revenue for the year amounted to £179,190 1s. 10d., against £151,605 12s. 3d. in 1898, being an increase of £27,584 9s. 7d. The cost of generation, which in 1898 was £76,736 8s. 7d., amounted in 1899 to £90,419 7s. 1d. or an increase of £13,682 18s. 6d. During the whole of the period under review the erection of the company's new generating station at Willesden was proceeded with, but owing to delays in the deliveries of constructional and other iron work the completion of the works was seriously hindered, with the result that from early in October to December 15th, when they commenced to supply current, the resources of the Manchester Square station were unduly taxed, and it was found necessary to temporarily withdraw the supply from certain of the circuits at hours of maximum demand. The directors have endeavoured to meet the consumers affected in what they regard as a fair and reasonable manner. In consequence of these interruptions the company was twice summoned at the Marylebone Police Court under the Electric Lighting Acts. On the first occasion the proceedings were postponed for three months, and on the second, after hearing evidence, nominal fines were imposed, the Magistrates in each case considering that the company, though technically at fault, were not to blame for the unfortunate interruptions which had occurred. Full particulars of the hearings of these summonses were circulated among the shareholders. Since December 15th, 1899, the Willesden generating station has been working satisfactorily. During the last Session of Parliament, the London County Council introduced a Bill to authorise the construction of a new street from Holborn to the Strand, which involved the compulsory acquisition by them of the company's works at Sardinia Street. The directors are pleased to state that a clause was obtained in this Bill by which the company's interests are fully protected. A protective clause was also obtained in the Central Electric Company's Bill. The balance to the credit of the revenue account, before providing for depreciation, is £66,392 17s. The directors have set aside £13,000 as an addition to the depreciation and reserve fund, carrying to the credit of the net revenue account (No. 5) the sum of £53,392 17s., which, with the balance brought forward from last account and other receipts, makes a total of £57,728 10s. After deducting debenture and share interest and other charges, there appears a balance of £25,660 6s. 3d. An interim dividend of 5s. per share on the ordinary share capital was paid on August 14th, 1899,

amounting to £19,679 12s. 8d., and the directors recommend that a further dividend of 5s. per share on such shares be now paid, making a total distribution of 10s. per share for the year, or 5 per cent. on the capital. This will absorb a further sum of £21,250, and leave a balance of £4,410 6s. 3d. to be carried forward to the next account. This result the directors consider to be satisfactory in view of the exceptional circumstances under which the working has been carried on during the year, and having regard also to the large amount of capital which, while entailing additional charges upon revenue, has been unproductive for practically the whole of the year. The number of 8-c.p. lamps supplied by the company increased during the year 1898 from 430,000 to 500,000. The present number of lamps connected is 509,000, and the applications show no signs of decrease. A report from the company's engineer is appended, showing that the satisfactory condition of the stations, machinery and plant has been maintained. The directors have elected Mr. James Carr Saunders and Mr. Frederick Leverton Harris to seats on the board, and have appointed Mr. W. Harrison Cripps to the office of chairman. The term of Mr. Frank Bailey's appointment as engineering director having expired, he has been elected an ordinary member of the board. The directors have appointed Mr. J. Conacher to be general manager of the company. In accordance with the articles of association, the following directors, viz., Frank Bailey, Esq., W. Harrison Cripps, Esq., and F. Leverton Harris, Esq., retire from the board, and are eligible for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and are eligible for re-election."

The report of the engineer appended to the directors' statement reads thus:—

To the Directors of the Metropolitan Electric Supply Company, Limited.

Gentlemen,—I have pleasure in certifying that, subject to normal depreciation, the company's stations, machinery and plant, are being maintained in an efficient condition, and have worked satisfactorily up to the present date.

REGINALD R. TODD, *Engineer.*

March 2nd, 1900.

Oldham, Ashton and Hyde Electric Tramway Company.

The directors' report for 1899, presented at the meeting held in London yesterday, states that £40,000 4 per cent. debentures have been issued. The premiums received, less expenses, amount to £322, and have been placed to a reserve fund. The total capital expenditure now amounts to £121,461. The total revenue from the date of commencing to work (June 12th, 1899) to December 31st last amounted to £12,606, and the expenditure (including debenture interest) to £8,186, leaving a net profit of £4,419. The directors propose a dividend at the rate of 5 per cent. per annum on the cumulative preference shares from August 15th to December 31st, 1899, £750; to repay £2,552 to the guarantors, being advances made by them to meet dividends on the cumulative preference shares from January 18th, 1898 (date of allotment of shares), to August 15th, 1899; to place to depreciation fund £500, and to carry forward £617. The company has appealed against the judgment given in the action brought by the Hyde Corporation to prevent the company using the feeder cables which have been laid under the footpaths.—An extraordinary meeting will be held to approve an extension light railway order promoted by the company.

The Northwich Electric Supply Company, Limited.

The second annual report of the directors, which was adopted at the meeting of shareholders last week, reads as follows:—"The directors beg to submit their report for the year ending December 31st, 1899, with statement of accounts and balance-sheet. A steady and continuous increase has been made in the number of consumers connected to the mains. On December 31st, 1898, there were 88 consumers, with an equivalent of 3,885 8-c.p. lamps; and during the year 1899 64 consumers have been added, with a total of 2,301 8-c.p. lamps, making a total on December 31st, 1899, of 152 consumers and 6,186 8-c.p. lamps. In addition seven motors, with an aggregate of 61 h.p., have been connected to the mains during the year. The length of mains laid to the end of the year is as follows:—Feeder mains, 5,720 yards; distributing mains, 10,560 yards; public lighting mains, 4,250 yards; service mains, 3,000 yards; making a gross total of 23,500 yards, or over 13½ miles. The principal extensions during the year are for the public and private lighting of Hartford, where the company have been accorded a large amount of support, 1,154 lamps having been connected in the parish since the middle of September. The Parish Council of Hartford have adopted electric lighting for the village, the whole of the roads of the village—about 2½ miles—having been lighted since November 14th, this being the first village in the kingdom to adopt public electric lighting throughout. Owing to the very encouraging manner in which the demand for electricity has risen, and with a view to obtaining still more consumers along the route of the mains, the directors decided to reduce the price, as from June 30th last, by adopting the Brighton maximum demand system of charging. From that date the charge for current has been 6d. per unit for the first hour's use per day of the maximum current demanded, and 4d. per unit for all consumption over and above that amount. This is equivalent to an all-round charge of about 5d. per unit, or a reduction of 15 per cent. With a view to encouraging small consumers, the directors decided to adopt a system of free wiring, with prepayment slot meters, which, in practice, is proving extremely successful, and the directors anticipate a large extension in this department. The system of mains is now being extended to Winnington, where substantial support has already been secured. It is anticipated that these extensions will be working during the month of March. Owing to the rapid and continued increase of business in the supply department of the company, the directors decided in December last to relinquish the wiring department, and have entered into an agreement with Messrs. Woods & Co., of 2, Gray's Inn Road, London, whereby they will do all the wiring previously done by the company. In consequence of the continued progression of the company and the extension of the area of supply it will be necessary to raise further capital, to obtain which the directors will submit a proposal for the issue of debentures. After writing off £51 9s. 11d. for the goodwill of the wiring department, the net profit for the year is £529 18s. 10½d., which, with a balance of £113 9s. 6½d. brought forward from last account, gives a total of £643 8s. 5d., from which, after deducting £28 off preliminary expenses account and setting aside £95 for depreciation, the directors recommend payment of a dividend at the rate of 3 per cent. per annum. There are two vacancies on the board of directors, one occasioned by the death of Mr. Thomas Moore, and the other by the retirement, by rotation, of Dr. R. J. Browne, who being eligible, offers himself for re-election. Messrs. Thos. Aldred and Son, the auditors, offer themselves for re-election."

Northampton Electric Light Company.

The annual general meeting of this company was held on February 22nd, Mr. F. H. Thornton presiding.

The Chairman regarded it as no small achievement that, in spite of a reduction of something like 20 per cent. in the price of current and an increase of about 15 per cent. in the price of coal, the company could achieve the same results as they did the year before, and were able to keep up the dividend, though it was a small one, to the same level as in 1898. They began the year with 13,061 lamps, and they ended the year with 19,763, an increase of 6,702; which was an improvement upon the previous year's increase, 1,977. The increase in the number of lamps was not altogether due to the reduction in the price of the current, but it was also partly due to the reduced cost of installation, which had been cheapened so much that an installation formerly costing 20s. to 25s. could now be done for about 10s., and no doubt the free wiring system had been found a great convenience to a great many customers. During the year the company had installed light in a great many private houses, and it was from the private houses that they had the best returns. They had installed the light in large buildings, and in four or five factories. There were now 14 motors in use, an equivalent of something like 50 h.p. During the year now begun the company proposed to raise the pressure of the current to about twice its present strength. The great increase in the mains, 2½ miles, was bringing in the results that they anticipated, and they found an increase for the month of January, 1900, of something like 60 per cent. of the units of electricity compared with 1899, and he regarded this as a very happy omen for the future success of the company.

Alderman Tomes seconded, and said that the company had not yet been able to give the shareholders the benefit of their success during 1899, because although there had been a large increase in the number of customers, a great many of them did not become connected till the last six weeks of the year. But though they did not make such a great difference to the company in 1899 the company now began to feel the effects.

The motion was unanimously adopted.

It was resolved that dividends be paid as follows:—6 per cent. and 5 per cent. on the 6 per cent. preference shares and 5 per cent. preference shares respectively, and 2 per cent. on the ordinary shares.

Brompton and Kensington Electricity Company.

The report of the directors for 1899, to be presented at the meeting to be held in London on 15th inst., states that the revenue account shows a credit balance of £18,181, which with £159 brought forward, and £1,237 interest received, makes £19,577. The directors recommend to place to credit of depreciation account £4,500, and in reduction of renewals suspense account £2,500, to pay remainder of dividend to December 31st, 1899, on the 7 per cent. cumulative preference shares £2,100, a dividend on the ordinary shares at 7 per cent. per annum, making 6 per cent. for the year £3,440, carrying forward £229. The supersedure of plant has proceeded so far that the company's station has now been practically re-modelled. The total estimated cost of the plant involved, less receipts from the sale of old material, will not exceed £26,702, of which £23,702 has been incurred to date. To provide for this the directors propose to appropriate £7,000 from the depreciation account and £2,500 from net revenue account, carrying forward £14,202 to a renewals suspense account, to be written off out of future profits, which the new plant should considerably enhance. The improved position of the company no longer requiring the special services for which he was appointed managing director, Mr. Page has decided to resign the office.

City of London Electric Lighting Company.

The total revenue for the past year was £187,253, of which expenses of generation and distribution absorb £69,478, and rent, rates, &c., £30,451. There is transferred to depreciation fund No. 1 £21,000, and to reserve fund £2,349, leaving, with £3,381 brought forward, a balance of £63,974. It is proposed to pay a dividend of 8s. on the ordinary shares, or 4 per cent. for the year, and to carry forward £1,622. The generation and distribution expenses for the year, including repairs and renewals, were 49·31 per cent. of the gross earnings, as compared with 36·1 per cent. for 1898, 31·3 for 1897, 34 per

cent. for 1896, 36·87 for 1895, 46 for 1894, and 54·2 for 1893. The increase in the percentage during the past year is due to a largely increased output having been supplied at a greatly increased rate of charge to the consumer. The number of customers being supplied is 8,738, compared with 7,415 at the end of 1898, and the number of lamps connected was 429,628, against 355,825. The B.O.T. units sold for private lighting for the year were 7,446,703, as compared with 5,837,317 in 1898. The directors have resolved to issue 20,000 ordinary shares of £10 each, being the balance of the additional £400,000 ordinary share capital created by a resolution passed at the meeting held in 1897. This issue of 20,000 ordinary shares will rank for divided as from January 1st, 1900, *pari passu* with the existing ordinary shares, and will be allotted at par *pro rata* to the holders of preference and ordinary shares who were registered in the books of the company on March 2nd, 1900, or to their nominees.

Bournemouth and Poole Electricity Supply Company, Limited.—The directors have decided to recommend payment of a dividend upon the ordinary shares of the company at the rate of 5 per cent per annum, less income-tax, for the year ended December 31st, 1899. The transfer books and register of members will be closed from the 9th to the 19th inst. inclusive.

Stock Exchange Notices.—The Stock Exchange Committee has appointed a special settling day as under:—Tuesday, March 13th.—St. James's and Pall Mall Electric Light Company, Limited—Further issue of 8,020 ordinary shares of £5 each, fully paid, Nos. 52,081 to 60,100, and has ordered these securities to be quoted in the Official List.

British Insulated Wire Company.—At a board meeting on Monday last applications for the new issue of shares were considered, and it was resolved that, in view of the fact that both the ordinary and preference shares were largely over applied for, the allotment of shares be adjourned until Wednesday, 7th inst., when letters of allotment and regret will be posted.

The City of London Electric Lighting Company.—The transfer books and register of members will be closed from 2nd to 15th inst., both days inclusive.

Barcelona Tramways Company, Limited.—The directors announce a dividend for 1899 of 2 per cent., or 4s. per share, tax free.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending March 3rd, 1900, were £177 6s. 8d.; receipts for corresponding period, 1899, £196 13s. 10d.; aggregate for half-year to date, £1,590 0s. 2d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 2nd, 1900, were £2,743 0s. 6d.; corresponding period, 1899, £2,498 15s. 10d.; increase, £244 4s. 8d.

The City and South London Railway Company.—The receipts for the week ending March 4th 1900 were £1,459: ditto March 5th, 1899, £1,111; increase, £348. Total receipts for half-year, 1900, to date, £10,473; corresponding period, 1899, £10,071; increase £402. Miles open March 4th, 1900, 3½; March 5th, 1899, 3½.

The Dover Corporation Tramways.—The receipts for the week ending March 3rd, 1900, were £139 16s. 9d.; March 4th, 1899, £139 13s. 5d.; increase, 3s. 6d. Total receipts to date, 1900, £1,809 17s. 7d.; corresponding period, 1899, £1,982 16s. 8d.; increase, £27 0s. 11d. Miles of track open, 1900, 8; 1899, 8. Car miles run, 1900, 4,909; 1899, 4,261. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, March 2nd, 1900, were as follows:—D. U. T. Co., horse cars, £50 15s. 3d.; ditto, electric cars, £2,938 13s. 0d.; D. S. D. Co., electric cars, £689 15s. 2d.; total, £3,629 3s. 5d.; corresponding week last year—D. U. T. Co., horse cars, £1,641 15s. 0d.; ditto, electric cars, £950 3s. 9d.; D. S. D. Co., electric cars, £656 4s. 9d.; total, £3,248 3s. 6d.; increase, £380 19s. 11d. Aggregate to date, £30,248 16s. 2d.; aggregate to date last year, £28,131 11s. 5d.; increase to date, £2,117 4s. 9d. The mileage worked is 42 miles electrically, 2 miles by horses, as against 18 miles electrically, 26 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending March 4th, 1900, were £673; week ending March 8th, 1899, £801; increase, £262. Number of cars, 1900, 28; 1899, 15. Total receipts to date, 1900, £28,060; 1899, £9,729. Miles of track open, 1900, 13; 1899, 6½.

The Liverpool Overhead Railway Company.—The receipts for the week ending March 4th, 1900, amounted to £1,432: corresponding week last year, £1,285; increase, £147. Total increase in traffics for half-year to date, £1,314.

STOCKS AND SHARES.

Wednesday Evening.

The relief of Ladysmith last week brought with it another relief for the Stock Exchange. While little fresh business has followed in its train throughout the markets generally, it is felt that the war is now in our hands, and time is the only thing needed to bring it to a successful conclusion, when the advent of peace shall usher in a vast amount of orders to the House. Whether this latter consummation will be brought about remains to be seen. The Budget proposals were also a strengthening tonic to the markets, which had been dreading a new issue of Consols to pay for the war. This fear having proved to be baseless, Consols advanced sharply, and the electric markets have benefitted considerably under the clearer skies in the political and the financial firmaments.

Electric Traction is still prominently to the front. Both Citys and Centrals are better in price. City and South London have added to their increase of last week by scoring another brace of points, it being stated that the company's new station at King William Street shows signs of becoming a great acquisition. Central London descriptions are all ¼ better, buyers coming into the market in intelligent anticipation of a demand for the shares as soon as the experimental train is running, which will now be in a few weeks' time. Waterloo and City stock is firm, and we look for no rise so long as the money market maintains its present rates. For a 3 per cent. investment the stock at par is as good a one as can be obtained anywhere, and as safe.

British Electric Traction are becoming almost a lively market, and the activity naturally makes for better prices, so long as the company's prosperity continues normal. The new shares are quoted 17, which is 10s. below that of the prior issue.

Proprietors of traction shares need not be alarmed at our announcement that a rival is in the field. Red-hot from the promoter's hands a proof prospectus of the Johnson-Lundell Electric Traction Company came to us. The capital, it is proposed, shall be £300,000. It will be time to criticise when the undertaking reaches the maturity of public issue—that is to say, if it ever does so. In some respects the prospectus reminds us of that of the British Westinghouse Electric and Manufacturing Company, whose 6 per cent. Preference shares, by the way, stand at £5, *i.e.*, par.

The supply section is quite busy. Most of the companies' reports are now facing the music, and the salient features of them all are the same as those we have mentioned from time to time in dealing with individual reports. Expanding business, increasing expenditure and want of more capital—those are the main points that catch the eye in glancing through the papers issued by the companies. Charing Cross shares weakened on account of the fire at the Maiden Lane station last Saturday, but with admirable promptitude the Chairman issued a reassuring circular to shareholders, telling them that most of the damage done is covered by insurance, and that the supply of the current was only stopped for a few hours even in the district most affected by the conflagration. Brompton and Kensington shares are uninfluenced by the excellent report now being distributed. The company is spending nearly £27,000 on new plant, but instead of making a fresh capital issue, the directors boldly carry forward a large sum to a renewal suspense account, which is to be written off out of future profits. The rest is provided for out of the depreciation and current revenue accounts.

Dr. Fletcher Little still attacks the Metropolitan Electric Supply Company with all his power at the meetings of the Marylebone Vestry. His latest move is the circulation of a letter comparing the Metropolitan Company's charges, years of existence, and method of supply with those of other prominent electric concerns. The London Electric Supply Company, it appears, is 13 years old, the St. James's is 10, the Chelsea nine, and the Metropolitan only eight years.

Amongst the various new issues either being made or on the way, must be mentioned the £70,000 worth of 4½ per cent. Debenture stock offered at 103 by the Bournemouth and Poole Electricity Supply, the company which secured from the County of London and Brush the interests formerly held by the latter in Bournemouth and the surrounding district, and in Richmond (Surrey). The stock is redeemable at 107 after 10 years, and the security seems sound. Bournemouth and Poole Ordinary (£10 shares) stand at 12½, and the 4½ per cent. Preference at 10½.

The National Telephone's new issue, of which we gave particulars a fortnight back, is now before the public, and the 4 per cent. Debenture stock that is offered at 98 is already quoted at 1 to 3 premium in the market. We should say that this was about as much as it is worth, but, of course, the fact of its being redeemable at any time after December 31st, 1904, at 105 per cent., offers some little attraction to many people. The new Ordinary shares are being issued at par, £5, and as the existing shares stand at 5 to 5¼, it must be conceded that they have very little to recommend them. The subscription lists closed on Thursday, March 8th.

Telegraph securities remain very quiet, and the market is uninteresting. Eastern Extensions continue to be bought upon the company's negotiations in Australia, but Eastern Ordinary is unaltered. Indo-European moved up a point upon the contention that what with war cables and famine cables, the company should be doing an excellent trade. The Anglo-American division is out of all favour with speculators, and the market is listlessly weak. Beyond one or two of the debenture stocks being quoted ex-dividend, there is no other change worth mentioning in the telegraph department.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation, Feb. 28th.	Closing Quotation, March 7th.	Business done during week ended March 7th. 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s	73/6	63 — 66	63 — 66	63	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	114½—115½	114½—115½	115½	115
3,062,240	Do. do. Deferred...	Stock	...	18s. %	£1 7s	14¾— 15¼	14½— 14¾	14⅝	14⅜
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	...	...	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,332,823£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	103 —105	103 —105	104½	103½
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	1 %	...	⅛— ¼	⅛— ¼	...	...
16,000	Cuba Telegraph	10	7 %	8 %	...	9 — 10	9 — 10	9¾	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	19 — 20	19 — 20	19¾	...
12,931	Direct Spanish Telegraph	5	4 %	...	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	101—105%	101 —105%	...	...
60,710£	Direct United States Cable	20	3¼%	3½%	3 %	11½— 12	11½— 12	11 11/16	11⅝
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	155 —160	155 —160	158	155
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	98 —101	98 —101	100½	98¾
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	116 —121	116 —121	116½	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	15½— 16	15¾— 16¼	16¼	15¾
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	100 —103	100 —103	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	115 —120	115 —120	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb., Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	102	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104%	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	...	11½— 11¾	11½— 12	11⅞	11 11/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15½— 16	15½— 16	16	15⅝
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	...	...	31 — 33	31 — 33	...	...
86,300	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	49 — 53	50 — 54	53	52
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	107 —110	104 —107 xd	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	½— ¾	½— ¾	...	...
86,492	Do. do. 5% Pref., Nos. 1 to 86,492	1	4 %	4 %	2½ %	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	5⅛— 5⅜xd	5 — 5¼xd	5¼	5 3/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 15 xd	14 — 15 xd	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 15 xd	14 — 15 xd	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5¼— 5½xd	5¼— 5¼xd	5 7/16	5⅜
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	97 —100	97 —100	98½	97½
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	¾— 1	¾— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	101 —104	101 —104	...	...
11,889	Reuter's	8	5 %	...	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	126 —131	129	...
58,000	United River Plate Telephone	5	5 %	6 %	6 %	4¾— 5¼	4¾— 5¼	5 1/16	...
16,639	Do. do. 5 % Cum. Pref. Nos. 1—16,639	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	..	...	...	103 —106	103 —106	...	...
200,000£	West African Telegraph, 5 % Debs.	100	%	...	...	98 —101	96 — 99 xd	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	100 —104	100 —104	...	...
205,993	Western Telegraph, Ltd., Nos. 1—205,993	10	...	...	...	14¾— 15¼	14¾— 15¼	15¼	14¾
75,000	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph	10	2%	...	...	¾— 1½	¾— 1½	1 1/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	9½— 9¾	9½— 9¾	9 13/16	9 13/16
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	7 — 8	7 — 8	...	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	104 —107	104 —107	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	...	...	98 —103	97 —102 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	...	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	...	...	8¼— 9¼	8½— 9½	...	...
30,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	10 — 11	9½— 10½	10⅛	...
20,000	Do. do. do. do. Nos. 30,001—50,000	5	...	...	...	9½— 10½	9 — 10	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5½— 6 xd	5½— 6	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	6 %	6 %	6 %	7⅞— 8½	7 — 8	8½	7⅞
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	...	...	110 —112	110 —112	111⅜	111
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	10 %	6 %	4 %	10 — 11	9½— 10½	10¼	10
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	13 — 14	13 — 14	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	...	9½— 10½	9½— 10½	10¼	9¾
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	12½— 13½	12½— 13½	13½	13⅜
200,000	Do. 4½% Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	109 —112	109 —112	110	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	5 %	7 %	...	4¾— 5¼	4¾— 5¼	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1¾— 2¼	1¾— 2¼	2⅛	...
48,050	Do. do. do. 6 % Pref.	5	...	6 %	...	4½— 5	4½— 5	5⅛	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	101 —103	101 —103	..	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	14 — 15	14 — 15	14½	13⅞
22,500	Do. Nos. 62,501 to 85,000	10	...	...	...	14 — 15	14 — 15	...	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	...	...	114 —117	114 —117	...	...
125,000	Do. 3½ % Mort. Deb. Stock Red.	Stock	...	...	...	95 — 97	95 — 97	96½	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	16 — 17	16 — 17	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	14½— 15½	15½	15½
20,000	Do. ----- do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9¼xd	8½— 9½	9¼	8⅞
65,000	South London Electricity Supply, Ord.	5	...	...	...	4 — 4½	3⅞— 4¼	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	12 %	12 %	13 %	13½— 14½xd	13½— 14½xd	14½	13 11/16

* Subject to Founder's Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

† Quotations on Liverpool Stock Exchange.
‡ Dividends paid in deferred share warrants, profits being used as capital

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Feb. 28th.	Closing Quotation Mar. 7th.	Business done week ended Mar. 7th, 1900. Highest.	Lowest.
		‡							
65,000	Aluminium shares, Nos. 1—65,000	1	10 %	...	...	2⅜— 3½	2⅜— 3½	3 3/16	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	97 —102	97 —102	...	...
80,000	British Electric Traction	10	...	6 %	...	16½— 17⅛	17 — 18	18	17½
30,000	Do. do. 6 % Cum. Pref. 30,001—60,000	10	...	...	...	13½— 13⅝	13½— 13⅝	13⅝	13 5/16
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	125 —128	126 —129	...	...
45,000‡	†British Electric Works Co., Ord. £1 shares, 50,001—95,000	...	...	...	...	15/16— 1 1/16	15/16— 1 1/16	...	...
50,000	† Do. do. 6 % Cum. Pref., 1—50,000 ...	...	...	...	...	⅞— 1	⅞— 1	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	99 —101	99 —101	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	...	...	20 %	12 — 13	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ...	5	...	...	...	6 — 6⅛	5⅞— 6⅛	...	...
90,000	Brush Elecl. Engng., Ord., 1 to 90,000	3	3 %	5 %	...	1⅞— 2⅛	1⅞— 2⅛	2	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	6 %	...	2⅛— 2⅛	2⅛— 2⅛	2⅛	...
125,000‡	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	108 —113 xd	108 —113xd	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	12½%	15 %	...	14 — 15	14 — 15	14⅞	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	111 —115	111 —115	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	9½— 10	9⅝— 10⅛	10⅛	10
61,033	Do. do. Pref. half-shares	5	...	...	...	4½— 5	4⅝— 5⅛	5⅛	5⅛
71,447	Do. do. Def. do.	5	...	...	...	4½— 5	4⅝— 5⅛	...	...
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	59 — 62	61 — 64	62	61½
37,000	Do. do. Ord. shares, Nos. 22,501 to 60,000 £5 10s. pd.	10	...	...	...	4 — 5	4 — 5	4⅛	...
32,098	Crompton & Co., Nos. 1 to 32,098	8	...	...	...	3½— 4	3½— 4	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	98 —101	98 101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	2 — 2⅛xd	2 — 2⅛	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	6 %	6 %	...	3½— 4⅛xd	3½— 4⅛	...	...
344,023	Do. do. 4 % Deb. Stock Red. ...	100	...	...	...	93 — 95	93 — 95	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	2⅛— 2⅜	2⅛— 2⅜	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	...	2⅜— 3⅛	2⅜— 3⅛	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	104 —107	104 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅝— ⅝	⅝— ⅝	...	...
9,600‡	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	...	14 — 15	14 — 15	14⅞	14½
12,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5½— 6	5½— 6	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%		...	110 —114 xd	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21⅛	21⅛
800,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —104	100 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	3½%	9¼ — 9⅝	9⅛— 9⅝	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	12½— 13	13 — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	39½	38
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	102 —105	102 —105	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000 ...	5	...	...	...	9 — 10	9 — 10	...	...
20,000	Do. do. 5% Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½— 6	5½— 6	...	...
540,000‡	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	101 —104	101 —104	104	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ % Debentures of £100, 104—107.
National Electric Free Wiring, 12/6 paid. ¾—⅞.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17—19.
Do. do. Pref. (£10 pd.), 10—11.
Smithfield Market Electric, 2—3.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—18; 1st Preference Cumulative 6 %, £5 (fully paid), 7⅛—8. Debentures, 108—106. Dividend, 1899, on Ordinary Shares 11 %.
Kidderminster and District Electric, Pref. (£6 pd.), 6—6½.
*T. Parker, £10 (fully paid), 18.

*. From Birmingham Share List.

Bank rate of discount 4 per cent. (January 25th, 1900).

MARKET QUOTATIONS, Wednesday, March 7th.

CHEMICALS, &c.	This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a ,, Nitric .. .. .. per cwt.	22/-	22/-	..
a ,, Oxalic .. .. .. per cwt.	32/-	32/-	..
a ,, Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	40/-	40/-	..
a Ammonia, Muriate (crystal) .. per ton	£32	£32	..
a ,, ,, ... per cwt.	£27	£27	..
a Bleaching powder .. .. per ton	£7	£7	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. per gal.	7/-	7/-	..
a ,, (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£25	£25	..
a Lead, Nitrate .. .. .. per ton	£25	£25	..
a ,, White Sugar .. .. per ton	£31	£31	..
a ,, Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks .. per lb.	5d.	5d.	..
a ,, Caustic (75/90 %) .. per ton	£34	£34	..
a ,, Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6	..
a ,, Recovered .. .. per ton	£5 10	£5 10	..
a ,, Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£10 15	£10 15	..
a ,, Crystals .. .. .. per ton	£8	£8	..
a ,, Bichromate, casks .. per lb.	4¼d.	4¼d.	..
METALS, &c.			
Aluminium Wire, in ton lots .. per ton	£224	£224	..
b ,, Sheet, in ton lots .. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£85 to £145	£85 to £145	..
c Brass (rolled metal 3' to 12') basis per lb.	8d.	8d.	..
c ,, Tube (brazed) .. .. per lb.	10d.	10d.	..
c ,, ,, (solid drawn) .. per lb.	9d.	9d.	..
c ,, Wire, basis .. .. per lb.	8¼d.	8¼d.	..
c Copper Tubes (brazed) .. .. per lb.	11¼d.	11¼d.	..
c ,, ,, (solid drawn) .. per lb.	11¾d.	11¾d.	..
g Copper Bars (best selected) .. per ton	£86	£86	..

METALS, &c. (*continued*).	This week.	Lastweek.	Inc. or Dec.
g Copper Sheet .. .. .. per ton	£88	£86	£2 inc.
g ,, Rod .. .. .. per ton	£88	£86	£2 inc.
c ,, (Electrolytic), Bars .. per ton	£85	£83	£2 inc.
c ,, ,, Sheets .. per ton	£94	£92	£2 inc.
c ,, ,, Rod .. per ton	£88	£86	£2 inc.
c ,, ,, H.C. wire per lb.	10d.	9¾d.	⅛d. inc.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f ,, Sheet .. .. .. per lb.	5/-	5/-	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	8/-	8/-	..
h India-rubber, Para fine .. per lb.	4/5	4/6	1d. dec.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i ,, Pig (Cleveland warrants) per ton	70/-	69/4½	7½d. inc.
i ,, Forgings, according to size per ton	From £11	From £11	..
i ,, Scrap, heavy .. .. per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire galvanised No. 8 .. per ton	£14 5	£14 5	..
g Lead, English Ingot .. .. per ton	£16 11 3 to £16 13 9	£16 10 to £16 11 3	inc.
g ,, ,, Sheet .. .. per ton	£18	£18	..
m Manganin Wire No. 28 .. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£9 12 6	£9 13 6	..
d Mica (in original cases), small per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rl'd str'p & sheet per lb.	From 1/3	From 1/3	..
o Platinum .. .. .. per oz.	£3 11	£3 11	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1/	10½d to 1/	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15 to £58	From £15 to £58	..
i Steel, Magnet, in bars	£152 to £153	£147 10 to £148 10 nom.	£4 10s. inc.
g Tin, block .. .. per ton	nom.		
g ,, foil .. .. per lb.	1/9	1/9	..
n ,, wire Nos. 1 to 16 .. .. per lb.	1/11	1/10	1d. inc.
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £70	£40 to £70	..
f Yarns, Cotton, Single 10lb. bundles pr lb.	8½d.	8d.	½d. inc.
f ,, Best Flax, 6 lbs. .. .. per lb.	5½d.	5½d.	..
f ,, Hemp, 3 ply 10 lbs. .. per lb.	14½d.	14d.	½d. inc.
f ,, ,, Russian, 10 lbs. per lb.	5½d.	5d.	½d. inc.
f ,, Jute, 180 lbs. rove .. per ton	£15	£15	..
h Zinc, Sheet (Vielle Montagne bnd.) p.t.	£27 5 nett.	£27 5 nett.	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e Messrs. Frederick Smith & Co.

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Rolling & Lewis.
j Messrs. Henry C. Yee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

THE ACTION OF ELECTRIC TRAMWAY CURRENTS ON SUBMARINE TELEGRAPH CABLES AND OTHER ELECTRIC CIRCUITS.*

By Prof. ANDREW JAMIESON, F.R.S.E. (Member).

(*Concluded from page* 329.)

The Various Probable Actions of the Tramway Currents on the Submarine Cable.

(1) *Electrolysis.*—The well-known action of electrolysis, on neighbouring underground conductors, such as gas and water pipes, whenever the fall of pressure along the rails exceeds a certain value, may be at once dismissed as having no effect upon the case in question. The underground cast-iron pipe containing the 450 yards of insulated

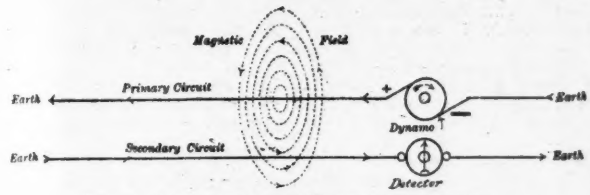


Fig. 5.—Direct Electro-Magnetic Induction.

conductor from the cable office to the cable hut, never showed any signs of electrolysis, and no such action has been observed as taking place in the sheathing of the submarine cable.

(2) *Affecting the Potential of the Earth Connection to the Receiving Instrument.*—At first sight, the possible action of erratic stray currents from the tramway system more or less continuously altering the potential of the receiving instrument's earth connection, is a fascinating idea to many; and this idea, as will be seen later on, is still entertained by certain cable electricians. But from the many

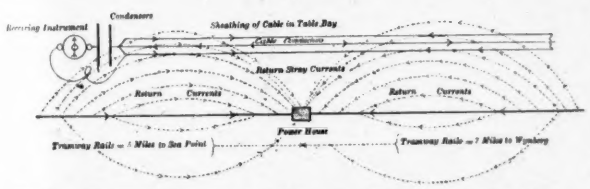


Fig. 6.—Stray Currents from Electric Tramway Rails, Inducing Disturbing Currents in a Parallel Submarine Cable.

attempts and failures of the Eastern Telegraph Company to obtain satisfactory results from a land or a sea "earth" connection placed in various positions, and at varying distances up to 12 miles from the receiving instruments, this action may also be dismissed as having no particular bearing upon the disturbances in question.

(3) *Direct Electro-Magnetic Induction.*—Although the well-known effect of electro-magnetic induction as shown by fig. 5, and which was first proved and announced by Faraday in 1831, always takes place between a circuit wherein the current is suddenly altering in strength and any other closed parallel or approximately parallel

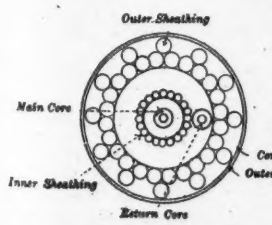


Fig. 7.—Coney Island Twin Shore End.

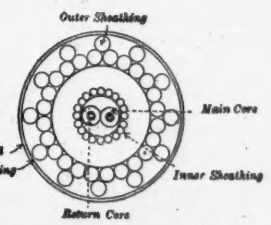


Fig. 8.—Twisted Twin Core Anti-Inductive Shore End.

conducting circuit, yet, I doubt, if the chief cause of the observed disturbances can be attributed to what may be termed *direct* electro-magnetic induction. By this term, I mean, the effect which would be directly, or at first hand, communicated to the insulated conductor of the submarine or underground cables from the erratic currents passing along the trolley wires in one direction and returning by the rails; or, by results due to the difference between these respective currents at any time. In the first place, the underground cable is contained in a strong cast-iron pipe, and although this pipe is much nearer to the tramway rails than to the trolley wires along the seaward end of Adderley Street; yet any direct electro-magnetic action due to the difference between the respective currents in them and their respective distances from the pipe, would naturally result in producing inductive currents in the pipe to a greater degree than in the so far magnetically shielded insulated conductor. A secondary inductive effect would, no doubt, be produced upon this insulated wire by the more direct induced currents in the cast-iron pipe. These secondary currents would, however, be opposite in direction to any direct electro-magnetic induction that might reach the wire. Again, the sheathing of the shore end of the submarine cable being not only double, but the outer armour being so heavy and compact (see figs. 7 and 8), the insulated conductor contained therein would also be very much shielded from any *direct* electro-magnetic effect. Besides which, the mean parallel distance for the first mile between the cable and the tramway is fully half a mile, and, thereafter, the cable diverges, not only in distance, but also in direction from the tramway route; therefore, I do not think the chief or most prevalent cause of the interferences to the receiving signals can be attributed under these circumstances to what we have called "direct electro-magnetic induction." I do not for a moment doubt, that direct electro-magnetic induction would take place through air or earth or sea or all combined at much greater distances, and even under less favourable conditions, with respect to parallelism and to sudden alterations in the strength of the primary currents than in the case in question, if only the cast-iron pipe surrounding the underground core and the heavy iron armour of the shore end were absent. These iron covers, however, in my opinion, not only to a great extent act as a magnetic shield, but, moreover, the electro-magnetic currents produced in them so act upon the insulated conductors contained therein, as to produce a current opposite in direction and in effect to any direct electric-magnetic induction in the cable conductor. No doubt the "splashes" or more violent "kicks" of the siphon in the Kelvin recorder, which were still observable up to the time of my leaving the Cape, may be attributed to the sudden closing or to the sudden freeing of a number of the motor circuits. For whenever the pre-arranged limits of the automatic cut-out switches are exceeded, due to a congregation of cars (say near the corner at the meeting of Darling and Adderley Streets or elsewhere not far from the cable) being started more or less simultaneously, then electro-magnetic induction has the best chance of exhibiting its effects. One day while standing near the switchboard in the power house, I noticed that certain of the automatic cut-out switches broke their circuits half a dozen times within a quarter of an hour at the pre-adjusted limit of 350 amperes; and, of course, they had also to be switched on again before the cars on that section or sections could start. Such sudden stoppage and starting a current of 350 amperes at 500 volts does undoubtedly cause *direct* electro-magnetic induction in all neighbouring parallel electrical circuits, whether they are in the air as in the case of bare or specially insulated wires, or buried in the earth, or laid in the form of a submarine armoured cable in the sea. These sudden electro-magnetic disturbances are, however, distinguishable from another and more frequent source of interference which might now be considered.

(4.) *Disturbances due to Leakage or Stray Return Currents from the Tramway Rails.*—In fig. 6 I have depicted graphically, by dotted curved lines, the "stray shunted" currents as they leave the tramway rails and find their way back to the negative poles of the dynamos in the tramway power house. When the length and the electrical resistance of the rails is taken into consideration, as well as the very heavy traffic which at times prevails in each of the two main sections to Wynberg and to Sea Point, there is no difficulty in believing that the limits of the fall of potential along the rails, as set down by the Board of Trade, are at times exceeded.

The seven-mile route from the power house to Wynberg is only a single line with numerous "turn-outs," whilst that to Sea Point is a double one. The rails in each case are 81 lbs. to the yard, with double flexible Chicago copper bonds past the fishplates at the rail joints. Cross bonds are also introduced between each pair of rails, at certain distances apart. The consequence is that when the traffic is heavy, some 30 to 40 per cent. of the return current finds a way back to the power house through the earth and the sea. Since the hard rocky nature of the Table Mountain side offers a greater resistance than that of the damp low-lying shore side, the major portion of the stray currents naturally follow the latter course. These stray currents freely pass through the Observatory grounds, a mile or more distant from the tramway line to Wynberg, and Dr. David Gill, the Astronomer Royal at the Cape, informed me that ever since the electric tramway first passed the Observatory, he had not been able to carry out a single delicate magnetic experiment within the grounds. These varying stray currents undoubtedly find a ready path to and along the heavy low resistance sheathing of the submarine cable on their way back to the power house, and, in doing so, they produce by induction correspondingly erratic currents in the cable conductor, which of necessity interfere with the weak receiving currents during their arrival at the Cape telegraph office. No wonder, then, that such interferences mystified and defied the most skilled telegraphists to decipher the messages, so long as the tramways were working, and so long as no proper anti-inductive method had been applied to cancel their baneful effects. It will be readily understood that the tramway company, having received full Government and municipal permission to adopt the overhead trolley system, with the rails for the return currents to the power house, and seeing that under such working conditions it could not possibly introduce any known and com-

* Paper read before the Institution of Engineers and Shipbuilders of Scotland, February, 1900.

mercially satisfactory means of preventing the natural interferences, it was willing to help the cable company as far as possible to effect the desired remedy.

Anti-Inductive Earthing Cables laid by the Eastern Telegraph Company.

In the end of January, 1897, the Eastern Telegraph Company laid a short cable of about 5 nauts as nearly as possible over the shore end of their main cable, fig. 3, and connected it to the earth side of the telegraph office recorder by means of a second underground cable inserted in another cast-iron pipe which lay parallel and close to the first pipe and cable. The sea end of the conductor of this short cable was earthed by soldering it to its sheathing, the soldered joint being protected from the sea water. By this it was hoped that a "sea earth" would be found, beyond the range of the tramway stray currents, to neutralise all inductive effects upon their main cable. So long as the tramway traffic remained light, and until the tramways were extended from Adderley Street to Sea Point on the one side, and from Mowbray to Wynberg on the other side, the telegraph company's staff was able to receive messages by aid of this short cable. There cannot be the slightest doubt, however, that it could not be laid precisely over and parallel to the main cable from a telegraph steamer, for the main cable lay at such a depth as to be entirely out of sight. The short cable might therefore be hundreds of feet away from the original one at various places without anyone being aware of the fact. Further, since the sheathing of this short cable was not of precisely the same kind and weight as that of the main cable shore-end, the induction upon its conductor, however evoked, would not be equal to the induction in the conductor of the main cable. Consequently, the induced currents through them would not exactly balance each other as they arrived at the opposite terminals of the receiving instrument. In other words, the balance was not perfect. It was, however, so very much better than with any of the previously mentioned plans, that members of the staff were able to receive messages until the extension of the tramways took place. After that, the Cable Company found it necessary to incur the still further expense of laying another cable, of 11 nauts, in a similar manner and earthing the same at Robben Island. It was also connected to the siphon recorder through an under-

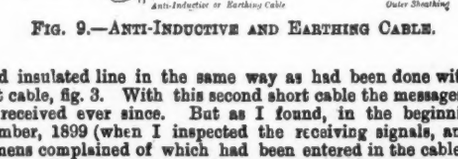


Fig. 9.—Anti-Inductive and Earthing Cable.

ground insulated line in the same way as had been done with the 5-naut cable, fig. 3. With this second short cable the messages have been received ever since. But as I found, in the beginning of September, 1899 (when I inspected the receiving signals, and the specimens complained of which had been entered in the cable office diary), the telegraph staff were still frequently bothered with "kicks" and "splashes." Upon joining up the 5-naut earthing cable to the recorder instead of the 11-naut one, I at once perceived that the interferences became much more pronounced; and with the earth side of the recorder connected directly to the sheathing of the main cable as in fig. 1, these interferences became so bad that I could scarcely read a single word.

Previous Anti-Induction Earthing Cables.

I could give a large number of previous instances of interruption to sea and land telegraphy and to telephony due to faulty earth connections, leakage from other sources through earth plates and between circuits, direct electro-magnetic induction from lightning, and lighting and transmission of power circuits, but this is the first instance in which I have personally observed indirect or secondary induction from stray shunted tramway currents in the case of a submarine cable. The Eastern Extension Telegraph Company had experienced similar interferences from the electric tramway lines at Madras, in the working of its submarine cables landed there; but it overcame them in a so far satisfactory manner by running a parallel underground cable as well as one out to sea for a few miles. Here, however, the tramway lines were not nearly so favourably situated with respect to parallelism to the cables, and hence the disturbing effects were not so pronounced as at the Cape. Messrs. Siemens Bros. & Co. had previously laid down a double cored underground landline and shore end cable at Coney Island to enable the Commercial Cable Company to bring its lines direct to the New York office, and at the same time, be free from interferences due to the neighbouring electric tramways. A cross section of the cable laid by Messrs. Siemens is illustrated by fig. 7, where it will be observed that the second or return core is placed between the inner or light sheathing, and the outer or heavy stranded armour. Here, again, the submarine portion was not nearly so parallel to the tramway lines as at Cape Town.

Proposed Remedies for Induction and Stray Current Interferences.

Taking into consideration all the circumstances at Cape Town, I reported to the Commission, before which I recently gave evidence, that nothing short of a symmetrically arranged and specially made "twin *twisted* core with double armouring" would do for the shore end, and that it would not require to be more than from two to three nauts (see fig. 8 *). One core of this special cable would require to be jointed to the core of the main cable in the bay, the sheathings thoroughly well spliced together, and the conductor of the second core soldered to the outer sheathing of the main cable, and there sealed from the water. The ends of these two cores at the cable hut would require to be connected to corresponding ends of an armoured "double-twisted core" encased in *one* thick cast-iron pipe placed underground between the cable hut and the telegraph office, and the conductors connected to the signalling condensers and the receiving instrument (as shown in fig. 9, in which the sending battery, switch, and keys have been omitted). Only thereby could all inductive effects from whatever source and however caused be equally and simultaneously evoked in the main and the short earthing conductors.*

Further, I strongly recommend the Tramway Company to obtain and place in circuit, with separate return feeders from different points along the rails, a sufficient number of negative boosters (or sucking dynamos), in order to reduce the return currents in the rails at these points to zero potential, and thus prevent the fall of pressure along any portion thereof ever exceeding the limits of the Board of Trade Rules. This would naturally stop electrolytic action on neighbouring pipes, and greatly reduce the potential, the strength, the range of stray currents, and hence the chance of their reaching the sheathing of the submarine cable and of acting inductively upon its conductor.

Finally, I believe that land telegraph, telephone, and other electric circuits, can be protected from all interfering influences of electric tramways by employing twisted forward and return insulated conductors, and that electrolysis may be prevented by employing heavy well-bonded rails with return feeders and sucking dynamos, whenever the fall of pressure along any section tends to exceed 5 volts.

* The author showed a specimen of this cable, which was kindly lent to him by Messrs. Siemens Bros. & Co.

* Since reading this paper the author has been informed that the recently laid shore end of the new cable from Cape Town to St. Helena has been made and connected in the above-mentioned way.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER BRANCH.

Abstract of Inaugural Address of Dr. Edward Hopkinson, Manchester, February 27th, 1900.

Electrical engineering, though in a sense the most specialised of all branches of engineering, is really the most cosmopolitan, depending upon many branches of fine science-mathematics, the whole range of physics, chemistry, and even to some extent the biological sciences, and playing an integral part throughout the vast field of engineering, so that the choice of a subject is a matter of no little difficulty.

I suppose there are in England alone at least a score of Societies whose proceedings are more or less of interest to electrical engineers, and whose members are annually addressed from the chair; in fact, taking account of the various sub-sections of such Societies I apprehend there are no fewer than 50 presidential addresses yearly. Surely the time has come when these might be curtailed both in number and length, and the time more usefully spent in other directions, for how is it possible except for the very few in the vanguard of science to say aught that is new, and that which is old it is vain to repeat.

In looking through the list of our members one cannot but be struck by the very large proportion who are intimately and directly connected with manufacturing engineering concerns; the larger proportion of our local members are, in one capacity or another, actively engaged in the management and control of the many industrial undertakings, either private or municipal, of which Manchester is probably the most important centre in the world.

English electrical engineering has been, and is, passing through a momentous epoch of its history. Before recovering from a strike of unprecedented length and extent, a period of extraordinary expansion in the general trade of the country, and quite sudden realisation by the public of the advantages of electric lighting, electric traction, electric transmission, and distribution of power, and many other applications of electric energy, had led to great demands on both manufacturers and undertakers, for which it cannot be said they have by any means been fully prepared, with the result that large orders for electrical plant have been placed abroad.

Let us take it for granted, for a moment only, for the sake of argument, and we will return to the assumption later, that the conditions in England are generally as favourable for manufacture as they are in other countries; then it is obvious that undertakers, including under the term more particularly municipalities and public companies, who are undertakers in the Parliamentary sense of the word, ought not to deprive their own ratepayers and constituents of work and order abroad, except by reason of inability of otherwise obtaining delivery in reasonable time or of serious difference in price. Primarily dependent, as they are, for their own prosperity upon the full employment of the working classes of this country, they cannot regard with indifference the passing of any work out of the country which can be done in it; nor can they throw the odium of unpreparedness entirely upon the manufacturers, as it is, I venture to think, as much their business and their interest to so forecast the future as to take such steps for increase of their plant to afford ample time for properly digested plans of extensions, and for the execution of the work, as it is the business of the manufacturer to provide the appliances for construction. Would the nation relieve the Admiralty

of Scotland, February, 1900.

ing conditions it could not possibly introduce any known and com-

or War Office of responsibility if they suddenly found that they wanted ships and guns with such rapidity and in such quantity that they had to buy in Germany? Would it not rather hold that the departments had shown lack of foresight and due preparation?

I asked you a moment ago to grant, for the sake of argument, that the conditions in England are generally as favourable as in other countries. Are they?—A large question with many answers. In one respect it must be admitted they are. English manufacturers find no inducement either in price or in quality to buy their coal, iron or steel, except in relatively infinitesimal quantities from abroad. But are our conditions of labour and our capabilities of design and management equal to those of foreign competitors? I cannot refer to the first without some apprehension, lest I should step on forbidden ground, knowing that opinions are various and feelings strong; yet for this very reason I think the problem cannot be too freely or openly discussed. Let us compare some of the conditions of labour which obtain with us, and those which obtain in the United States. Given a particular piece of work, done in a particular way and with given appliances, I have never seen any evidence to prove that the work is done more cheaply in America. The American workman has higher wages, and probably accomplishes somewhat more in a given time, so that the net result is probably about the same. That the output of an American workman is somewhat greater than that of his British brother is partly due, no doubt, to mere physical causes, a more bracing climate during the greater part of the year, and the fact that American workshops are, as a rule, better lighted, heated and ventilated, than most English shops, and that more attention generally is paid to hygienic conditions; partly to the greater stress which characterises American life generally, and has grown to be inherent in the national character; but chiefly due to the fact, in my opinion, that American workmen are in general very much better educated than English workmen, not in the sense of mere technical knowledge of their work, but are generally more cultured and have a wider mental horizon. I believe it to be a quite general law of human effort that the better educated a man is, the harder he will work at whatever his hands find to do, and that apart from the question of skill of handicraft the educated man will produce more in a given time than the uneducated. The cultured man has more to look forward to when his work is accomplished, and values his earnings and his leisure more highly, and so has greater incentive, and being accustomed during his years of early training to constant effort, it becomes a mental and moral habit to work to the utmost of his capacity.

If these considerations be true, we may anticipate the future will bring a gradual increase in the rate of work, as our educational systems become more developed and extended, as, indeed, has no doubt been the case during the last 50 years; but this tendency will bring and has brought us to face another problem, viz, the time of working. Concurrently with increase in the rate of work there has been a steady diminution in the hours of work, and probably we have not yet reached the limit. The efficiency of a particularly manufacturing plant is measured by the ratio of the difference between the market value of the production and its cost to the capital employed. There are various fixed losses or charges, rent, rates, management, and so on, which I need not enumerate; there are other charges which are a function of the time during which the plant is worked, for example, cost of power, lighting, &c., and, finally, there is the cost of labour, which, again, is a function of the hours of labour. Maximum efficiency is, therefore, determined by a linear differential equation. The problem has its counterpart in the determination of the proper size of a conductor for the transmission of electric energy, the solution of which is expressed by Lord Kelvin's rule; or it is, perhaps, still more analogous to the problem, when is a dynamo working at maximum efficiency? The answer to which is, as you know, when the $C^2 R$ losses in the armature are equal to the sum of all other losses. Unfortunately, dynamos never do work at their point of maximum efficiency, as long before then injurious sparking takes place and the armatures are overheated. Possibly similar phenomena would occur in our workshops if you endeavoured to apply too vigorously the solution I have indicated. The solution depends primarily on the function you choose to represent the dependence of the cost of labour on the hours of work. If any of you are inclined to work out the problem for yourselves on the lines I have suggested, I would commend to your notice the very excellent and truly scientific investigation recently made by Mr. Crompton into a corresponding and just as difficult a problem, the proper length of crank in a bicycle, pointing out in passing that in general a long crank corresponds to short hours.

But to return, we assumed for the argument in comparing English and American labour that the appliances were the same, an assumption at the present time certainly not generally justified by the facts. American electrical industry, at any rate, is so much more concentrated into comparatively few shops on a larger scale than most of our English shops that there has been far greater possibility of standardisation in every detail, and repetition of types, and consequent inducment to the introduction of automatic machine tools; but our workshops are changing in this respect, and any ground we may have relatively lost may be regained, and certainly will be recovered if those reponsible for the laying out of our electrical undertakings realise that machinery of standard size and manufacture is not only cheaper, but intrinsically better and more accurate in workmanship than machinery built to suit their own particular idiosyncracies. Who would think of asking a Lancashire boiler maker for a boiler 29 feet by 7 feet 9 inches, instead of 30 feet by 8 inches, because he wanted 5,800 lbs. of steam per hour instead of 6,000; but too often is the builder of electrical plant forced to design his machines to fit the station, and to meet all manner of conditions which ought to have been subservient to the plant.

No doubt the introduction of automatic machine tools in England has been, and is, attended by many difficulties with the workpeople, but I am optimistic enough to believe that as our workpeople become better educated and more intelligently alive to their own interests, these difficulties will rapidly disappear. This is not by any means necessarily coincident with the larger adoption of piece work, and will not, I think, be solved by this means. Piece work is open to many objections, and often breaks down. Rightly or wrongly, it is always regarded with suspicion by the English working man, and is often unsatisfactory to the employer. Though in some American shops it has been adopted to a large extent, with satisfactory results, there is much less piece work in practice in America than is generally supposed. The largest engine-building shop in the world has no piece work whatever, but a modification of it, with which you may, perhaps, not be acquainted, but which is well worth study, is largely obtaining in America. I refer to the system known as the "premium" system, where the workman, while receiving in any case his rated wages, has a definite price fixed for each piece of work, and divides with the employer according to an agreed scale any profit made by producing at a lower cost than the fixed price.

Once more return to an assumption I made in an earlier part of my remarks, viz, that the management of our English manufacturing or undertaking businesses is on a par with that of corresponding businesses in the United States, and under the word "management" I would include not merely shop and works management, but all that makes for intelligent and scientific design and technical control. I will not attempt an answer as to whether the assumption is justified, but it is worth noting that our American competitors have given proof of their own views on this point by the fact that more than one are establishing works in this country. They, at least, must have come to the conclusion that the general conditions of manufacture are as propitious in England as they are in the States, and that labour difficulties are no greater here than there, but by the introduction of the appliances they have so well worked out, the systems of shop management, and the designs and technical control they have elaborated, they look for advantages which justify their emigration. Whether it be a fact or not that we have any lee-way to make up in this direction, it is, at any rate, a profitable reflection to consider how we may have lost ground, if lost it we have.

This leads us into the large field of the right training of electrical engineers and managers for our electrical undertakings, a large field which I cannot do more than most briefly refer to to-night. I for one would most heartily endorse the dictum of Sir Andrew Noble that the education of our English public schools and universities lays a foundation for successful struggle in the world's field of battle which is absolutely without rival, but it is a foundation only; upon it must be built an adequate superstructure of technical knowledge and skill. Much progress has been made, and is being made, in England, but it must be admitted we are still far behind, which I venture to think is chiefly due to the want of frank recognition of and hearty co-operation, not on the part of our public men, but of our managers and designers with the admirable institutions which already exist in this country. In laboratory and experimental equipment the technical schools and technical branches of the American Universities far excel anything we have—with few exceptions—in this country, and it is not provided for the most part out of beer money or local taxation, but is the free and generous gift of manufacturing concerns and the captains of industry in the country, who are far sighted enough to realise that by such support they are taking the first steps toward building up and ensuring the lasting prosperity of their own industries. We in the North of England have the opportunity afforded us for like support by the splendid institutions at our very doors, our university colleges and our municipal technical schools, all of them now provided with, or rapidly making provision for, adequate laboratories and workshops and most scientific teaching, and lacking only the earnest co-operation of the responsible managers and controllers of our undertakings. As a significant illustration of what I have been saying, I may mention that the Professor of Engineering at Cambridge told me a few days ago that the management of a large American concern about to start in this country recently applied to him to recommend a dozen of his students to take up responsible posts, after brief further training in America, believing that nowhere else could they obtain better material for their purpose.

If in the future the scientific training in a technical school or the technical departments of our universities is to largely replace the old systems of apprentices and pupilage, a much wider responsibility is thrown on the teachers and professors than the mere imparting of knowledge or development of manipulative skill. It rests with them to teach the general principles upon which all successful manufacture must be based, and to influence the entire mental attitude of their pupils toward the profession for which they are training. If they fail in this they may indeed instruct but will not educate; and we shall have a new class of "technics" who will hinder rather than promote industrial progress. To avoid such dangers we cannot insist too strongly on the importance of the closest possible co-operation and interchange of opinion between the responsible and practical managers of our industries and members of the profession on the one hand, and the managers and teachers of our technical schools on the other hand. The free interchange of opinion and discussion of methods is essential to the welfare of both.

Take two illustrations of such general statements. We have been talking much of late, but doing less, towards standardisation of electrical work. Manufacturers know perfectly well the need of it, but are practically powerless as they have no option but to provide what they are asked for. Now, if the profession generally could agree from time to time upon certain standards, and every young engineer before he leaves school or college be trained to repeat them, to understand the reason for them, and to look upon departure from them without cogent cause as bad practice, they would very soon be universally adopted. Or as another example, I suppose nine-tenths of educated opinion in England has been for the last 10 or 20 years in

favour of the adoption of the metric system as tending towards more accurate work, involving much saving in labour of computation, and facilitating our relations in foreign markets. Enlightened manufacturers are fully alive to its advantages, but cannot make headway against the mere dead weight of characteristic English dislike to change. Now, if the teachers in technical schools would be bold enough to agree to write all their text-books in the metric system, set every problem or example in it, and make their pupils think in centimetre-grammes instead of foot-pounds, and be allowed to translate their results into hundredweights, ounces, drams, pennyweights, inches, sixty-fourths of an inch, and any other of our national abominations, as valuable arithmetical exercise only, we should very soon have such a preponderance of influence in favour of the metric system that its national adoption would no longer be delayed.

Technical education does not end in school or college, but must be continued through life, and one at least of the chief instruments of it is our technical press and the publications of our technical societies.

We, members of the late Society of Northern Electrical Engineers, after seven years of individual growth, have just taken an important step in this direction by our willing amalgamation with the older and more influential Institution of Electrical Engineers in London, which, while leaving us full control of our local organisation, will I am convinced, greatly conduce to increased usefulness and promote those objects with which our Society was founded. The time will, I trust, come when the same influence working in other channels and with stronger currents, will finally lead to the combination of all British engineers, whether civil, mechanical, naval, or electrical, purely professional, or engaged in the control of manufactures, into one great Institution, with a roll of at least 20,000 members, and an income sufficient to provide not only a great central house and library in the metropolis, but also subsidiary houses and libraries in the chief centres of industry, and to ensure the rapid publication in convenient form of all new work which will widen the knowledge and resources of engineers, stronger than any of the trade guilds of the Middle Ages, or the great Corporation of the Learned Professions, maintaining and extending the prestige, honour, and usefulness of British engineers throughout the world.

THE DESIGNING OF ELECTRICAL GENERATING STATIONS.*

By ALFRED ROBERTS.

The following are the notes of this lecture, these being amplified as the author proceeded. The paper was written with the object of creating an interesting discussion. The lantern slides with which the lecture was illustrated were generally of the Chelsea Electricity Supply Company's generating station, of which Mr. Roberts was the architect:—

In complying with the Council's request to read a paper on the above subject, I did so with some diffidence, fearing it was hardly of sufficient general interest, electrical generating stations being comparatively few and far between, and their design being often entrusted to electrical consulting engineers, who make a speciality of this class of work.

However, I hope to be able to give a description of a typical station, together with some particulars and data, and to show some views of exteriors, interiors, and details, that may be of some general interest.

The first matter to be considered, which naturally largely affects the design, is the selection of site. In selecting a site many matters of vital importance to the ultimate economical working have to be considered; it should, if practicable, be near a river, canal, or railway, so that coal can be unloaded direct from barges or trucks into the coal bunkers, preventing the necessity of cartage, which involves a large extra outlay each year.

It should also, if possible, not be in the centre of a residential neighbourhood, as this involves many difficulties, such as complaints as to alleged vibration, noise, smoke, condensed steam, &c., in most cases unfounded, but at the same time involving cost to refute. One instance in this respect came under my notice where adjoining owners brought an action for damages in respect of vibration; they stated they had kept careful note of the times when the vibration complained of was extremely bad, and the worst period was when the company in question were able to prove they were not running any engines at all. Another instance was a chimney shaft in the centre of a residential neighbourhood, in connection with a former generating station that had been disused for this purpose on account of the company requiring much larger works; the chimney shaft therefore being entirely out of use, and having no flues or boilers connected therewith, complaints were made by adjoining owners of the smoke, &c., which in this case happily were not difficult to refute.

Another consideration in selecting a site is possible actions for damage to ancient lights, this, of course, is necessary in all cases, but more particularly so in the case of an electric light company, most people thinking that a company of this description with a large capital behind them are "fair game to shoot at," and, therefore, endeavour to obtain injunctions and other pleasant legal hindrances which are annoying to the architect, who is generally pressed to rush the building up as quickly as possible.

One other, and although last, by no means least, important thing to be considered in selecting a site is space for future extension—in starting, a company usually does not wish to overburden itself with a large capital, and, therefore, the ground taken is often only sufficient for the building immediately required; in the course of a few years as the company grows and has to meet a larger demand for supply of current, more generating plant is required and larger buildings necessary to contain same, and this then means either having two or more stations with a larger staff required than if concentrated in one station only, or obtaining statutory powers (in itself an expensive luxury) and the compulsory purchasing of the various interests of adjoining owners, and occupiers, when enormous claims have to be met and compensations paid; it is, therefore, false economy in the first place not to acquire a large enough site for all contingencies of extension and growth that may be anticipated for many years to come.

Other matters in selecting a site have to be considered, such as the nature of subsoil, facilities for drainage into parish sewers, &c, but as these are common in all building operations, and not special to electric light buildings, I will make no particular reference to them.

Having considered the questions relating to acquisition of site, the next matter for consideration is the design and construction of the buildings. In the first place, it is usual for an electrical engineer to decide upon the system of supply to be adopted, and to formulate a scheme and prepare sketch plans showing disposition and space required for machinery, plant, &c.—the architect then has to design his buildings to meet the requirements of the engineer, and practically as a shell to cover and protect the engineering plant. The ideas and wishes of the electrical engineer should therefore always be studied and adopted, as the primary function of a building of this description is to supply current and not to be a testimony of the architect's artistic taste (if he has any). Engineers' architectural ideas, however, as a rule do not run on parallel lines with those of an architect (for instance, Vauxhall Bridge), but the *suaviter in modo* system is far preferable, rather than endeavouring to force one's own taste and inclinations.

The plan of necessity depends to a large extent upon the system of supply adopted (*i.e.*, alternating or continuous current), also upon the shape and contour of site, but simplicity and economy of working should be the key note.

It is needless to say in the London district the buildings must be planned in accordance with the Factory Act, also the London Building Act, the latter, however, having special clauses relating to electrical generating stations, whereby the Council have power to authorise buildings to be erected of greater cubical dimension than 250,000 cubic feet, and in other respects to exempt such buildings from any of the provisions of the Act if they think fit.

The following are the principal departments for which provision must be made in the plan:—(1) coal stores; (2) boiler house; (3) engine house; (4) workshops; (5) stores; (6) meter and testing rooms; (7) engineer's apartments; (8) offices; also battery rooms if any batteries are proposed to be erected at the generating station.

1. *Coal Stores.*—These should be situated adjoining and readily accessible from the boiler house, and should be divided into a number of bunkers, to obviate danger of fire and for other reasons; one to each pair of boilers is a convenient arrangement, so that a check can be obtained upon the consumption per boiler. Generally, however, from contingencies of site, the coal bunkers cannot all be placed near the boilers; in that case it is necessary to have a system of iron tip-up trucks running on narrow-gauge rails from the vaults, with turn-tables at any point where the trucks have to turn at right-angles. The doors to bunkers should be of iron, hung to lift with counterbalance weights. Flooring is usually of concrete or blue Staffordshire bricks. Where the coal is shot into bunkers out of carts it is well to have several removable coal plates and shoots to each bunker rather than one central one, as in the latter case it is difficult to fill the coal bunker to its utmost capacity without trimming the coal, which entails much labour.

As to capacity of coal vaults, sufficient coal should be accommodated, if possible, to supply the boilers for at least three weeks to a month during the winter months, when the load is greatest, and, of course, if space be available, the greater the amount of coal storage capacity the better.

2. *The Boiler House.*—A convenient arrangement is for the boiler house, where practicable, to run parallel with the coal bunkers, and with the engine house. It is usual to sink the level of the boiler house floor some 8 feet or 10 feet below that of the engine house, so that the steam pipe from the crown of the boilers should be conveniently placed with regard to the engines, also so that coal can be shot down from the ground level into the coal bunkers beneath, the flooring whereof necessarily being at the same level as the boiler house floor for ease of stoking. The space required in the boiler house depends upon the type and size of boilers, but there should be at least a space of 16 feet to 18 feet between the boiler and wall opposite fire door for convenience of stoking, also so that boilers, drums, and tubes can be conveniently removed, swung round, and replaced with new ones, and for this purpose also large doors must be provided for ingress and egress of new and old boilers, as may be required in the course of years.

The boiler house should be lofty, well lighted, and ventilated by a continuous skylight running from end to end of the building with louvre boarding at the sides, the skylight being glazed with one of the many patent systems of glazing rather than the old-fashioned wooden bar.

Space must be provided in the boiler house for further engineering plant in addition to the boilers, such as feed water heating and detartarising apparatus, Green's economisers, &c., depending upon

* Paper read before the Society of Architects, London, January 25th, 1900.

the scheme adopted and particulars of space required, which must be obtained from the engineer when planning the building.

Stokers' lavatory and urinals should be provided readily accessible from the boiler house, also a stokers' mess room with cooking range, &c.

With regard to the chimney shaft or shafts, if a single shaft is decided upon it is best to place it in the centre of the range of boilers with the horizontal flue running right and left thereof, so that boilers can be added as the works grow, and in selecting the position of the shaft, future extension must be borne in mind; it is, however, advisable, where funds and space permit, to have two shafts of smaller capacity rather than one shaft of large capacity, so that in the event of repairs being necessitated through damage from lightning or other causes, one can be shut down whilst the other is working; the area of the shaft should also be amply large enough to provide for all future boilers that may be required; also, particularly in the London districts, it is advisable to carry up the shafts at least 150 to 200 feet, whether this height is required for draught or not, so as to distribute the products of combustion at as high a level as possible.

The shaft must also, of course, be designed in the London districts in accordance with the regulations of the Building Act. I fear it would be wearying, and extend this paper too much to touch upon the calculations requisite in designing a shaft, relating to draught, wind pressure, stability, &c., all of which, however, are of much interest, but I must content myself this evening by making a few general remarks relating to construction only.

There is a diversity of opinion as to the best form of chimney, some authorities arguing that a circular chimney is better than a square; the shape usually adopted for electrical stations, however, is an octagonal form of unequal sides, or rather a square chimney with the corners taken off. In calculating the area it must be borne in mind that the actual effective area of a chimney is less than the entire internal cross-sectional area of the shaft, as the velocity of the gases is retarded by friction on the sides of the shaft, and it is usual to take for the effective area the total area less 2 inches all round.

The horizontal flues conveying the gases from the boilers to the shaft should be of a larger sectional area than the shaft, as these get constricted by deposit of soot, and if entering the shaft from opposite sides a midriff, or central division wall constructed of firebrick should be carried up the centre of the shaft some 15 or 20 feet.

The shaft foundations of necessity are of vital importance, and must be of sufficient area to carry the load, which is usually very great, without sinking into the ground beneath. They should be allowed to stand some months before the brickwork of the superstructure is commenced, as it takes some time for a large body of concrete 30 or 40 feet square by 8 or 10 feet deep to set. The bricks should be specially selected, particularly at the base, to withstand the load, which often amounts to 8 or 10 tons or more per foot super. They must not, with the exception of the cap and footings, be laid in cement on account of its unyielding nature, and its not withstanding heat so well as lime mortar, also a shaft built in cement usually cracks.

The materials should be frequently tested during the erection of shaft, particularly bricks for crushing strains.

An extremely good mortar for shafts which I have used, and which is used largely in the North, is composed of blue lias lime, sharp sand, and foundry ashes, in the proportion of one of lime, two of sand, and three of ashes; the joints should be kept thin, and to prevent the shaft being blown out of the upright before the mortar has set, the brickwork should not be carried up too quickly.

A special bond is often adopted for shafts in which a large number of stretchers are used, as longitudinal tenacity is required to prevent a shaft splitting; for this reason hoop iron bond well tarred and sanded should also be built in at frequent intervals. In selecting the position for a shaft it is preferable that it should stand alone and not be attached to any buildings—if, however, from necessity of plan it must be in continuation of walls of a building, there should be no bond between the shaft and the wall adjoining, but a straight joint to allow the shaft to expand and contract—also it should be built first, so that any settlement may take place before walls are built adjoining.

The cap should be of simple design, not of too great projection, and little or no stonework employed in its construction, as in the event of this becoming disintegrated by frost, it is costly and difficult to repair—also, a heavy cap causes the shaft to oscillate in a wind with longer pulsations, and there is more chance of its being overthrown. A cast-iron capping built up in sections and bolted together forms, to my mind, the best finish at the top, and to this the lightning conductor can be readily fixed and stayed.

The shaft should be frequently plumbed to ensure a uniform batter, and great care should be taken in its construction to see no bats are used.

A firebrick lining is necessary, which should be carried up according to the height of the shaft some 80 to 100 feet; the firebricks are laid in fireclay and are usually carried up perpendicularly (*i.e.*, with no batter) with a space averaging about 2 inches between the outer wall and the lining—it must have no bond with the outer wall, and, to steady it, headers are usually projected through the 2-inch space at intervals to touch the lining with sand joints.

To prevent soot and cinders falling and blocking up the 2-inch cavity, the brickwork of the shaft must be racked out to cover up the cavity at the top, but room must be left to allow the firebrick lining to expand.

It is essential in firing a chimney for the first time, that heat should not be applied too suddenly, or there is danger of it splitting, so it is well to allow a little heat to pass up the chimney for some weeks before it is necessary to use it to its full capacity.

Foot irons are usually built into the interior of the shaft from base to cap, to afford access for repairs, &c., and in most electric generating shafts the exhaust steam pipe is carried up the centre of the shaft; the stays to keep same upright must not be bonded into the firebrick lining or main walls, but should rest on the offsets where the brickwork is reduced in thickness, to allow the exhaust pipe to expand and contract; as this exhaust pipe and the heated column of steam inside forms the readiest path for a flash of lightning, it must be carefully earthed and connected up to the lightning conductor.

The boilers usually adopted in London stations are of the water-tube type, as with these steam can be more quickly got up than with any other form, and this is an essential where sudden fogs and consequent darkness so prevalent.

3. *The Engine House*, as I before said, should be parallel, if possible, with boiler house, so that steam pipes from boilers are as short as possible, and can be carried direct through the separating wall to engine. Its dimensions, of course, depend upon the number of engines and type proposed, and here the engineer must again be consulted.

It must provide accommodation not only for the engines and dynamos, but for switchboards, and should also either contain engineers' mess room and lavatory, or have same conveniently adjoining.

It should be lofty, well lighted and ventilated by either skylights or ranges of windows, so planned that thorough ventilation can be obtained, as it is essential not only for the personal comfort of the staff, but also for the plant, that the temperature should not be too high.

Cleanliness is of extreme importance in the engine house, as dry, gritty particles in the atmosphere, or blown about by the wind, would shortly do irreparable damage to the bearings of the machinery, revolving at such high speeds as it does. For this reason, therefore, it is usual to face the walls (and where stores and other departments are over the engine house, the ceiling also) with glazed bricks, which are cleanly, and reflect the light, ensuring a bright engine house; these can also be easily wiped down, and therefore save the annual cost of distempering or painting the wall surfaces that would otherwise be necessary.

Window frames in the engine house (also the boiler house) should be of steel or iron, rather than wood, as the unavoidably high temperatures cause the latter to shrink and wind, besides which the former are more fireproof.

An overhead traveller is essential in an engine house for erection and removal of engines, dynamos, &c., and corbels should be built in the walls as the work proceeds, or some other provision made for carrying the rails upon which it travels.

The flooring to the engine house must receive careful consideration. It should be carried entirely independently of the engine beds, so that the vibration set up by the engines should not be transmitted thereby, and it should be paved with some material that is cleanly, not slippery, and of insulating material if possible. Wood block flooring soon gets greasy and unsightly, and the best material I have found so far is unglazed red tiling, although this has the objection of not being a good insulating material.

The engine beds are usually constructed of a continuous block of concrete (not separate beds for each engine), which is carried down 6 or 8 feet and carefully constructed and planned, so that vibration shall not be transmitted to the ground beneath. Many methods have been tried, successfully and otherwise, to prevent the transmission of vibration. That adopted at the Chelsea station, which has proved very satisfactory, is to first construct a foundation of concrete about 9 inches deep, on this sheet lead is placed, then two layers of continuous matting similar to an ordinary door mat but very much thicker; on this lead sheeting is again laid, and on these insulating layers the concrete superstructure of the engine bed, about 7 feet deep, is erected.

The position of the holding down bolts for the engines must be ascertained, and boxes constructed and accurately placed in the right position before the concrete is shot into the beds, so that after the concrete has set the wooden boxes can be taken out and the holding-down bolts with anchor plates attached at bottom can be let into the cavities thus formed, and grouted in with fine concrete and cement.

Switchboards should be constructed of some fireproof material, slate slabs in timber framing being one of the best forms of construction. The switchboards should be raised one step above the engine house floor level, on a continuous platform, so as to isolate the switches and enable the operator working same to have a good view of the engines and dynamos. India-rubber mats are provided to stand on when operating the switches.

A convenient office should be arranged if practicable for the electrical engineer in charge, with a window looking into and commanding the working of the engine house.

4. *Workshops* must be provided for carpenters, engineers, and fitters, &c., with lavatories, mess room, and office for foreman, the floor space for these depending upon the size of the works; there is little of special interest in the construction of these.

5. *Stores* are an essential department of an electrical station; they should be conveniently situated near the workshops, also, if on the upper floors, lifts and hoists must be provided in connection with same; racks are requisite for the various articles stored, and an office for storekeeper at the entrance.

The stores generally, like the whole of the building, should be of fireproof construction, and a special store for oil provided with iron doors. In calculating the strains and stresses in steel-construction carrying floor of stores, it is well to err on the side of excess, as the loads carried are usually very great.

6. *Meter and Testing Rooms* have nothing special to call for remark; stoves should be provided here for warming purposes, and benches for storing meters, testing, &c.

7. *Engineers' Apartments* should be situated naturally with the best outlook, and if over the engine house, made sound-proof, as well as

fireproof as far as possible; the accommodation required, of course, depends on the number of the staff.

8. *Offices* are often situated away from the generating station, and must provide accommodation for secretary and staff, chief engineer and staff, draughtsmen's rooms and board room, and have nothing special to call for note.

Battery rooms must be well ventilated to allow of the escape of gases, and the floors should be of cement or acid-proof asphalte, with channels therein to carry off contents of the cells if they should get broken.

Accommodation must be provided on the roof in some convenient and accessible position for water tanks, as a large storage of water is essential, so that in the event of burst mains or other causes preventing supply, no inconvenience is occasioned.

With regard to construction generally, an electrical generating station should be substantial, and of fire-resisting materials, as it is of extreme importance to prevent fire, not only on account of the damage done to works, but as a fire would damage plant and prevent the supply of current, which is a most serious matter; also the premiums charged by insurance companies for electrical buildings are extremely high in any case, and would be more so, unless the buildings throughout were of a fireproof nature.

A system of fire hydrants should be fitted throughout the building, and in most electrical stations the staff are exercised in fire drill.

All walls (at any rate those of engine house) should be carried down to same level as foundations of engine beds, and a clear space should be left all round the building between external walls and those of adjoining buildings to prevent transmission of any vibration.

There are many other points in the planning and construction of electrical generating stations that require consideration, but I hope to have given some general idea of the special matters to be thought of that may prove of interest, and upon which an interesting discussion will follow.

ELECTRICAL VOLUNTEERS FOR THE FRONT.

A "SEND OFF" dinner was given on Saturday at the Princes Restaurant, Piccadilly, to the active service contingent—51 officers and men—of the Electrical Engineers (R.E) Volunteers who are leaving shortly for South Africa. Lord Kelvin, honorary colonel of the corps, was in the chair.

After the loyal toasts had been honoured,

Sir W. H. PREECE proposed the "Army, Navy, and Auxiliary Forces," and remarked that though no man in the British Empire was called upon to bear arms against his will, there were in this Empire of ours over a million men under arms. We were a nation of fighters. He believed with the Duke of Wellington that Waterloo was won in the fields of Eton. In their cricket and football teams boys learned first to obey, and then, if they were good at it, to command. He was old enough to remember the Crimean war, and one of his first duties as an electrical engineer, and as assistant to Mr. Latimer Clarke, was to prepare the details of a telegraph equipment that was sent out to the Crimea. Warfare had changed since then. They had seen what traction could do to improve transport. It was certain that their friend, Major Crompton, would make things hum. By the aid of the electrical engineer the whole world had been knit into one bond of friendship and patriotism—he meant the British Empire; it was very nearly the whole world. Was there ever such an event as that which took place two days ago, when in the morning they heard of the relief of Ladysmith, and in the evening from all countries, from every part of the Empire there was first a prayer of thankfulness to the God of battles for success, and then a loud song of triumph?

Major-General WEBBER, who responded, said the military engineers represented the fourth arm of the service. While the rifleman had to use his rifle in the most scientific way he could, and the cavalryman had to use his sword and lance, the engineer had to use all the forces of nature, and to use them for attack and defence.

Lord KELVIN, in proposing "The Guests," said when the corps of electrical engineer volunteers was founded by the late Dr. Hopkinson it was for the purpose of applying the resources of science, and especially of electrical science, to the defence of the British Empire. He was sure it would have been the greatest pleasure possible for Dr. Hopkinson, as it was for his son, Captain Hopkinson, to know that its services were actually asked for by Lord Roberts, and that the War Office had agreed to send out a contingent of the corps for active service in South Africa under immediate command of Captain Lloyd, R.E. Electricity would prove to be of the utmost importance in a variety of ways. It could be used in mining and in blowing up the enemy, and there were minor applications. A general would be able to look to his charts and arrange his plans, and his clerks to write out his orders for the morning, with the aid of the incandescent light. Never before in the history of warfare had the electric searchlight been brought to the front. The War Office had not yet had formal notification that the contingent was ready to go on board ship, but he hoped the notification would be given before three or four days. He did not think the War Office and the Admiralty would wait very long before finding a transport. They looked on Major Crompton as the first living authority on motors—steam motors, gas engine motors, bicycles, motors of every available form of energy. Motors were destined to play a very important part not only in vehicular traffic in the streets of London but in warfare. Hitherto they had not been tried or used. Every general in the South African field force, if he did not care for electric light and was satisfied with a tallow candle, would at least appreciate machines that would haul a big gun up to the top of a kopje for him. The machines that Major Crompton had devised for bringing the electric light, the searchlights, and the projectors to the front, were directly adaptable also to carry great guns up to the top of hills to put them into places where man, oxen, or horse-power could not take them. They might look for very ample results from the traction engines that were going out with the corps. At the same time they must not run too fast. Suppose, for a moment, the traction engines did not bring the guns up to the top of a hill at all, they would have done their work; they would have done their work if they brought the electric projector up to the firing line, without any horses to be shot down, with one or two men under a shield ready to act and start the firing with a ray of light. He could say, from actual knowledge, that Lord Roberts wanted it. If the war was not all over in a short time, a second detachment would go out. There might be a good long time in which searchlights would be useful, and he should not be surprised if a good many members of the corps, who went out now, would stay for a year or more, as a field force would be required for some time after the war was over. He thought no volunteers were more splendid than the electrical engineers. Every man of the corps left a good position at home at a great and immediate sacrifice. He hoped they would be repaid many times over. They gave up everything for their country's sake, and if that was not true patriotism he did not know what was. They were to be admired for what they were doing. Conscription was not required for this country. All who were not disqualified were eager to serve. What a contrast it was to the miserable scribblings of the playwrights who wrote on decadence. Where was the decadence here? What young man, who was worth the name of a young man, was not now volunteering, and trying to get out in the service of his country. There was no such thing as decadence in any class in the British Empire. Speaking on behalf of the hosts, they wished they were going with their guests; they envied them; they wished them success. They were all ready to lay down their lives, and he knew no greater virtue than that. They wished them every success, and thanked them for the honour they had done to electrical engineering.

Major CROMPTON responded, and said that thanks to the extreme care with which they had been examined by their own medical chief, Dr. Bateman, not one of those who went up was rejected—a thing that could not be said of any other corps in the land. It said a little for electricity. For the work they had to do there had never been a more carefully selected body of men got ready for embarkation. Electricity was to be used on land as it already was at sea, to detect the approach of an enemy, but besides that they wanted the light ray to become a weapon of offence as well as defence. In these days when everything got into the papers, and they were in telegraphic communication with Kruger, it was of some considerable importance that he should not tell them everything, but he thought they would make Kruger sit up. With reference to the motor traction engine, water and fuel would be difficult to get in South Africa. The ideal motive power would have been a perfected oil engine, but that did not exist at the present time. He was thrown back on the best propelled steam engine. He believed they had secured the best engine for the purpose. To come to the projectors, up to the time of the conception of this movement, projectors were heavy pieces of material, and it required an entirely new departure to make them mobile. They had adopted the field artillery plan of mounting the projector on a carriage similar to that of a gun, and it could be hooked up to a limber drawn by mules or with drag ropes by men. It would be part of their duties to lay considerable lengths of cable under trying circumstances—he meant a perpetual hail of lead coming on the ground from external sources. They also had entirely new apparatus which he hoped would work satisfactorily. For working the searchlight, accurate means of communication was essential between the engine that supplied the power for the searchlight which provided the ray. They did that by telephones, and they had succeeded in getting a perfected form of telephone that was used by foreign armies, and which had not hitherto been used in this country. They hoped to show the Army Signalling Department something new in the way of making telephone or signalling connections. Kruger had telegraphed to him, "Send your detachment along at once. The electric light has failed, and prisoners are escaping as fast as possible." They had only to get it up, and he thought Kruger would detain Steyn at Bloemfontein, and their object might be defeated, because he must be put under Röntgen rays before they got out there.

Captain LLOYD also responded to the toast: He found he was commanding a detachment of men knowing more about electricity than he did. How was he to give orders to such men—he a simple amateur. They were not soldiers. They were making their livings—making a great deal more than he was—as technical and experienced men in the electrical profession. They were not going out to make money, but they would gain honour and glory. He found men getting perhaps 40s. or 50s. a week, going and enlisting for 1s. 1d. a day, and 3d. for messing. It was an extraordinary thing. It showed absolute devotion to their country. They were giving up everything, simply and solely to serve their country. It was the grandest thing he had ever heard of. He had just seen the first delivered sets of projectors mounted on gun carriages, and he felt certain they would be got up to any *inaccessible* place. [That the gallant officer is of Irish extraction here became evident]

Prof. PERRY in proposing Lord Kelvin's health, said though he was not able to go out to South Africa, he had spent a very long life in helping the young men who were going out. When the shells were bursting on their projectors he hoped the young men would not lose their heads. He hoped they would do credit to themselves as the volunteers of the Institution of Electrical Engineers. He envied them the chance they had of seeing how useful these electrical appliances could be in warfare, and seeing exactly how to apply them. They were going to show the War Office how to give to a whole division of the British army sufficient traction engine equipment to make it possible for the transport to be made quite independent of railway.

Lord Kelvin, in response, said he could almost carry himself back 40 years when he was in the 1st Lanarkshire Rifle Volunteers, and khaki was their uniform. He felt it a great honour for a retired captain of volunteers to be promoted in one great step to the honour of being hon. colonel of the Electrical Engineers Volunteer Corps. He thanked them most warmly; he thanked his old friend and pupil Prof. Perry, and he wished them all God speed in the great work on which they were now entering.

The gathering broke up after the singing of "Auld Lang Syne," and repeated rounds of cheers for the men, their officers, Lord Kelvin, and Lord Roberts.

AMERICAN COMPETITION AND STATE HELP.

Our cousins across the Atlantic are evidently not disposed to rest satisfied with their recent striking progress as an exporting nation, for among the Bills which are to be pushed forward in the American House of Representatives during the present session are several which relate to commerce and industry. An interesting summary of these is given in the issue of *Electricity* (New York) for February 14th. In view of the competition with which British manufacturers are now meeting in every quarter of the world, it is of interest to glance at the measures and proposals put forward by their chief rivals for rendering this competition more effective and severe.

One of the most important of these relates to the appointment of a Commission to report upon the establishment of a National Commercial University at Washington. The argument used in support of this proposal is the success attained by such institutions in Germany and in England in training men for the higher commercial posts and duties in foreign countries. We are afraid that the eulogy as regards ourselves is a little premature; but in a few years the proposed commercial departments of the new London and Birmingham Universities may have supplied our present deficiencies in this respect.

The measure, second in importance to the above, is a Bill to create a special department of the Government for commerce and industry. This department is to have charge of all the manufacturing interests of the country, and is to devote itself *especially* to promoting extensions of the markets for American goods abroad. Our own Board of Trade is, we suppose, the prototype of this new department, but our Foreign Office and Colonial Office have charge of the trading interests in foreign countries and in the Colonies respectively. This division of responsibilities brings in its train certain disadvantages which the American plan will avoid, and our own system ought to be centralised.

A third measure relates to the samples and statistics collected by the organisers of the Philadelphia Commercial Museum in 1898 and 1899. A grant of £40,000 is asked in order to make this collection of greater service to American manufacturers.

The samples collected by our Colonial Office in 1897 and 1898 from South American countries are our only equivalent to the collection made for the Philadelphia Commercial Museum. These samples have been exhibited at several centres of industry in this country, but it is reported that manufacturers have paid little attention to them. It is evident, therefore, that we shall have to follow the American example of bringing these samples to the manufacturer still more completely, if such collections are to be utilised in the best possible manner.

The remaining measures to be introduced during the present session of Congress are summarised by *Electricity*, as follows:—

Other grist in the National Legislative mill includes Bills to reorganise the consular service, to establish the metric standards of weights and measures, to incorporate the National Association of Manufacturers, for the purpose of giving additional stability to that organisation, and for the appointment of a commission of industrial experts to study trade conditions in the Orient with a view of increasing American trade in that vast territory. It will be seen that all these various measures are designed to directly or indirectly promote the export trade of this country, and as nearly every manufacturer is interested in the export problem, the speedy passage of these measures should be urged upon Congress.

BOILER LEGISLATION.

There are always some busybodies hard at work doing their best to cripple the industries of the country by unnecessary and ill-advised legislation. The Bill for providing Government inspection of land boilers is one of these. The men supporting or promoting it are certainly not famous for their soundness on economic questions, and as for this new attempt to interfere with industry, we trust all steam users will take an interest in it and do all they can to defeat it. The first reading of the Bill was set down for Wednesday last, and we are glad to know that some opposition was being organised.

The provisions of the Bill include, among others, the stopping of every boiler twice a year for *thorough* inspection. In itself, this would be a small matter; but those who know anything of the ways of the Board of Trade officials must be perfectly aware that this stoppage will mean often a wait of many days pending such time as it may suit the inspector's convenience or whim to make his inspection, and such inspectors are to be appointed by the Board of Trade, whose present staff of inspectors have shown extraordinarily little common sense in dealing with the duties that have come under their care in connection with explosions under the Boiler Explosions Act. It is provided that if any defect be found the boiler shall not be worked until it is put right. Now, this is simply ridiculous. Certainly no boiler ought to be worked with a dangerous defect, but it would be foolish to stop a factory because of a trivial defect that might become dangerous if not soon attended to. We maintain, and always have maintained, that the care of boilers in this country has been looked to by the various boiler insurance companies with far more zeal and far more intelligence than could be expected from a Government department.

The threatened measure provides that the inspectors should be boiler makers by trade. Now is not this a foolish thing, when all experience shows that the best inspectors are mostly engineers? We have known one or two good men who were boiler makers, but the majority of good men are engineers by training, and boiler makers, as a class, are not suitable for the work. Altogether, we look upon the Bill as most mischievous. It is an attempt to tread the dangerous paths of centralisation of government that have made slaves of the men of Germany and other bureaucratically-ruled countries. All that can be now claimed as required in this country is, that the authority of the boiler insurance companies should be somewhat stiffened so that the few instances in which they fail to enforce their recommendations may, if resulting in disasters, cause a recoil upon the heads of the boiler owners that they would not care to risk.

ELECTRIC TRACTION.

Any contribution from Mr. Swinburne's pen is sure to contain a very large number of epigrams to the column—perhaps as much as one-third will be more or less epigrammatic, and this is consistent also with very much sound common sense.

A reference in the Electrical Review to the name of Swinburne need hardly be explained as dealing with the expert engineer rather than the poet, with James instead of Algernon, and it is to an article by the former in the current issue of *Feilden's Magazine* that these remarks relate.

Mr. Swinburne has a good many smart and some useful things to say when dealing generally with the subject of electric traction; in these days of popular lantern lectures, &c., even electric tramways are beginning to be familiar in quarters where they are never likely to be found at work. But our author's great point is taken when he deals with the "future" of electric traction.

Although apparently ready to pour ridicule upon those who dogmatise hereon—(he says "there is a good opening for a competent prophet in connection with the future of electrical tramways and road traffic. What is wanted is a definite prophet, not a vague gentleman whose reports fit anything that happens subsequently")—Mr. Swinburne himself ventures to enunciate some very far-reaching prophecies which may with advantage be studied and digested by promoters keenly impressed with the magic of the words "electric traction," and by municipalisers who think that a permanent and perennial gold mine is as nothing compared with a system of electric street tramways.

In quoting the words of Mr. Beaumont, another traction expert, Mr. Swinburne lays down his general principle thus: "Tramways are a protest against the badness of roads."

Consequently, improve your roads, and make reliable, cheap, and comfortable automobiles; the tramway then immediately becomes an inelastic, clumsy nuisance, expensive to maintain, and by no means a thing of beauty to admire.

At present Mr. Swinburne admits that the automobile consists practically of "a hullabarattle and a smell, with a casualty notice next day;" but he has very strong hopes of it if only freedom is given for development. Certainly, in comparison with the horse, the objections to the automobile on sanitary or æsthetic grounds are valueless.

Mr. Swinburne has some very pointed remarks on the quadruped or "corn motor." He is "nearly as foolish as the hen, and is dirty and insanitary on a larger scale. He has been with us over 5,000 years [more than that, we think, Mr. Swinburne], and has not learned even manners or decency!" Even the much-valued horse of trade does not satisfy our author. "Cart horses," he says, "should learn to be more *fluent* with their legs, or disappear." It is surely just a shade hypercritical to expect the goods engine to run satisfactorily at 60 miles an hour.

Putting the horse on one side, however, as Mr. Swinburne is anxious to do, we certainly think that the distant future

of tramways, perhaps their not very distant future, has hardly received sufficient thought and careful consideration either at the hands of companies or corporations. Mr. Swinburne crystallises the matter in a paragraph:—"If the streets and roads are smooth and hard—in fact, if we have decent roads and successful automobiles, the need for tramways, electrically or otherwise worked, is gone."

And he is right, too; the only question is whether we shall see these successful automobiles within the next 20 years or so. Mr. Swinburne seems to think we shall. If we do, what value will the electric tramways of that day have, as compared with systems of efficient automobiles running in any required direction, paying no wayleaves for use of streets, &c., nor heavy outlays upon paving or causeway; unhampered by consideration of overhead wires, or distance from generating station; and not liable to be bought up in a few years' time for their value as scrap?

Verily, the legislation and local authorities of this country may have just as much to answer for, in the future of tramway work, as they now have by consequence of past oppression; and the time may come when the epitaph to be written over tramway enterprise will be "It *never* had a chance."

If accumulator men will only wake up and design a plate of some very light metal (perhaps they might as well while they are at it, invent the metal itself) with an enormous electro-chemical reaction in a very simple and harmless electrolyte; why, the thing is done!

Mr. Swinburne, it is pleasing to notice, gives the electric tramway "a few years at the very least!" We think that so far as electric self-contained automobiles are concerned, it will be "a good many years," but progress with gas and oil vehicles, and even with steam-driven cars has been extremely rapid of late, and busy as electric tramway interests now are and will be for a long while, yet it should not be forgotten that the really efficient electric automobile will in all probability prove a more useful and more permanent device than the electric trolley car, taking it all round, and it ought, therefore, to be fostered so that, whatever the ultimate form of vehicle for passenger traffic, electrical power will be at the back of it.

OBITUARY.

Emile M. H. Andreoli.

In our last issue we notified the decease of this industrious worker in the field of applied electricity, who for the last eight or nine years was a regular contributor to our pages. A few details as to his life and labours will doubtless be of interest to many of our readers.

M. Andreoli was born in 1835 at Besançon, the chief town of the Department of Doubs, in the east of France. He received a classical education, and at the early age of 19 was appointed Professor of History at the Lycée. After the Franco-Prussian war he came to England, and was for many years a special correspondent to the *Indépendance Belge*, the *Gaulois*, and other Continental papers. He was also for a time financial editor of the *World*, in succession to Mr. Labouchère, and he established a weekly journal entitled *The Paris Exhibition of 1878*. Subsequently to that date, he devoted the greater portion of his time to science and its applications; and one of his earliest inventions was a secondary battery element obtained by fusing a compound of lead chloride within the apertures of a lead *grid*. In 1891 he commenced his first researches on the production of ozone; and in 1894-5 he obtained some interesting results in the deposition of gold from cyanide solutions by means of "secondary electrolysis"—a current being passed through a tank containing free metallic plates arranged transversely, and gold being deposited mainly on the cathode surfaces of those plates, to the extent of 98 per cent. of the precious metal originally in solution. It was during these experiments he found that an anode of lead does not dissolve, but becomes peroxidised, in a cyanide solution, a discovery on which he based a patent for the use of peroxidised lead plates in the electrolysis of such solutions containing gold. For the cathode he used plates of iron, from which the deposited gold was removed by immersing the plates in molten lead. Thus, in the Andreoli process, the arrangement of Siemens & Halske, in which iron was used for the anodes and lead for the cathodes, was reversed. The Andreoli process was purchased by the Rand Central Ore Reduction Company, Limited, who had been working the process of Siemens & Halske.

In 1896 much progress had been made in the production of ozone on a large scale, and, by obviating the heating of the apparatus through the agency of circulating water, Mr. Andreoli was enabled to obtain 30 grammes of ozone per H.P.-hour, with potentials ranging from 12,000 to 30,000 volts. Further researches enabled him to announce that, by the use of opposed electrodes in the form respectively of grids and of flat plates, separated by a dielectric, such as glass or mica, from 100 to 120 grammes of ozone could be obtained per kilowatt. Last year M. Andreoli devoted the whole of his time, under the supervision of one of the foremost bacteriologists of the Jenner Institution of Preventive Medicine, to experiments on the sterilisation of water by means of ozone, and in December last he was able to state that, with the expenditure of 1 KW., costing about 1d., as much as 2,200 gallons of river water could be sterilised. We must not omit at least to mention the experiments on the purification of air, and other sanitary and medical applications of ozone, and also the domestic apparatus for producing this allotropic form of oxygen, by which the inventor hoped to benefit humanity.

The review of the "Progress of Electro-Chemistry During the Last 25 Years," which was one of the special articles on the occasion of the issue of No. 1,000 of this journal, was from the pen of M. Andreoli. In addition to his other work, he was a regular contributor to *L'Electricien* (Paris) and to the *Engineering and Mining Journal* of New York. Of a modest and retiring disposition, he was seldom seen at any public gathering; but his was a well-known figure at the British Museum and Patent Office libraries, in the exercise of his untiring industry in scientific research. He leaves many regrets amongst those who had the pleasure of his acquaintance.

OPEN v. ENCLOSED MOTORS FOR STATIONARY WORK

By CHARLES LEVEN.

The present demand for small enclosed motors has reached such a height that I dare say out of a hundred motors sold 75 are of the enclosed type. Why the small open type motor has been laid aside seems a puzzle, but the fact remains that the consulting engineer, the contractor, the insurance inspector, and, last but not least, the consumer, all want enclosed motors.

That the latter wants them can readily be understood, as we know the public is afraid of anything electrical, and presumably thinks that when a motor is enclosed the deadly currents are arrested.

The shunt motor, which is the commercial motor for stationary work, is an apparatus which has proved of enormous utility, and is certainly recognised as a useful article, but still it is only a tool, or a machine if you like, and, like other tools and machines, must have its proper attention.

I need not refer to oiling, as that is, of course, understood, but it must also be wiped off and cleaned, and this is most essential, particularly if copper brushes are used. Many a motor has burned out through copper dust having lodged between the commutator segments or got in behind the canvas or fibre head of the armature. This might not have happened had the motor been of the open type, for such an occurrence would at once have come under the attendant's notice.

I must add that in some parts of the kingdom the insurance companies have actually forbidden the erection of open type motors in their district, and demand that all motors shall be enclosed. Now, which is the best policy to pursue? To invite a fire risk, or to be able to prevent one? With the open type motor all parts are exposed and easily accessible,

and any slight trouble which might arise, and which perhaps would lead to damage, could at once be remedied; but this is certainly not the case with the enclosed motor, and it is a well-known fact that in many instances the enclosed motor has not been opened or looked after until it has actually stopped running.

The word "enclosed," as applied to motors, is happily very elastic, and as it is construed, embodies motors which are very wide open, or perhaps, covered with a screen or wire netting. Then there is the semi-enclosed motor (a capital expression for an open motor), and the *really* enclosed motor, a motor that is air-tight, dust proof, and, in some instances, water-tight. The latter motor must, however, be built on quite different lines to the others, as it has no circulation of fresh air whatsoever, no chance to cool off, and consequently must be of much larger proportions. If a specification calls for a 100 H.P. motor that will not heat more than 75° after, say, three hours' run at full load, a machine of a certain size and weight must be employed, and the motor of the enclosed type that would meet this condition would actually do 150 H.P. if it were open.

Now, which machine is therefore the most efficient? Certainly the one with the greatest proportional output.

The matter of brushes is of great importance, and the enclosed motor should unconditionally have carbon brushes to prevent the above-mentioned formation of copper dust, preferably radial brush holders, and on no consideration tangent brush holders with copper brushes, constructed in such a way that some day we might find the motor running with one brush and one brush holder screw, the other brush having accidentally slipped away. This should, of course, not happen on a well-designed motor, but we know only too well it has occurred over and over again. A mishap of this kind would also easily have been averted on the open type motor.

For machinery to run satisfactorily it must have proper attention, and the more this machinery comes under the direct notice of the attendant and his superiors, the better is it taken care of, and in no case has an attendant a better chance of showing his watchfulness than when he is looking after an electric motor; and, on the other hand, if the motor does not receive the proper attention it will soon show it. It is therefore but natural that the open motor will receive the best attention, though the enclosed motor needs it the most. How much good, for instance, does not a drop of oil do now and again passed over the commutator; in fact, it is absolutely necessary if you wish to maintain that deep dark gloss on the commutator so essential to the successful running of the motor, but this cannot so easily be done with the enclosed motor. And let us not forget that, if a motor commences to spark, this spark will not pass away of itself. On the contrary, it will always get worse. It is easy enough to take a little spark away, but most cumbersome to stop the big flashes, and again get the motor to run smoothly after the commutator has literally been eaten up, and in most cases this means turning off the commutator.

No doubt the open type motor is therefore put to work under far more favourable conditions than its enclosed rival, and in my opinion in special cases only should the enclosed motor have the preference. The bulk of motors which are used, for instance, in printing establishments, machine shops, on lifts, or for other industrial purposes, should certainly be of the open type.

And why is the enclosed form not used for large size machines? In how many instances do we see motors of over 100 H.P. of the enclosed type? Very rarely indeed, that such a motor is ever put on the market. And why are not generators enclosed? Specifications for generators issued by engineers comprise machines of such and such capacity, which will stand so and so much overload, with an increase of temperature of, say, 70°. Would anybody ever think of tendering for an enclosed type of generator, even if it should not be specified that the generator wanted must be of the open type? If this generator in question were a machine of, say, 200 KW. capacity, it would at least have to be made big enough for 300 KW. if it had to be entirely enclosed and not heat more than 70°.

In all modern central stations the open type generator is installed, presumably because the central station engineer as a rule knows what is wanted, and what will best answer his purpose, and certainly the open type machines are not only installed because there is no great fire risk attached to central station work, but simply because the best result can be had from such open machines.

The foregoing is based upon facts from practical experience, and I do not look upon an open motor as a fire hazard any more than a fire-place in a dwelling, a gas stove, or for that matter, a gas jet. On the other hand, if you want a motor for a powder magazine or perhaps a lyddite factory, put in an enclosed one.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1900.

Compiled expressly for this Journal by W. P. Thompson & Co. Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

3,297. "Improvements in electricity meters." Chamberlain & Hookham, Limited, and S. H. Holden. Dated February 19th.

3,254. "Improvements in and connected with underground conduit and surface contact electric railways." A. M. Taylor. Dated February 19th.

3,258. "Improvements in electric switches." A. F. Spooner. (B. L. Neveur, France.) Dated February 19th.

3,264. "Improvements in and relating to the armatures of electric motors also applicable as a meter for electric currents." C. Perdrisat. Dated February 19th.

3,279. "Improvements in and relating to electrical ignition devices for gas and like internal combustion engines." E. Wells. Dated February 19th.

3,315. "Improvements in and relating to electric heating apparatus." A. G. Brookes. (Boston Electric Heating and Power Co., United States.) Dated February 20th. (Complete.)

3,343. "Improvements in telegraphic receiving and translating arrangements." A. Muirhead. Dated February 20th.

3,325. "Improvements in or relating to incandescence bodies for electric glow lamps." A. Just. Dated February 20th.

3,361. "Improvements in the manufacture of secondary batteries." J. G. Hathaway. Dated February 20th. (Complete.)

3,371. "Improvements in and relating to electric heaters and switches therefor." E. F. Porter. Dated February 20th. (Complete.)

3,441. "An improved system of telephonic communication and signalling." M. Byng and F. G. Bell. Dated February 21st.

3,461. "Improvements in electro-magnetic brakes." The Westinghouse Brake Company, Limited. (F. C. Newell and E. M. Herr, United States.) Dated February 21st.

3,468. "Improvements in electrical generating machinery." T. Kay. Dated February 22nd.

3,469. "Improvements in cutting the slots or teeth in the armature cores of dynamo-electric machines and the like." H. Noble and P. Lund. Dated February 22nd.

3,481. "Improvements in and relating to resistances for electric circuits." L. Newitt. Dated February 22nd.

3,501. "Improvements in electric alarums." W. C. Hill. Dated February 22nd.

3,520. "Improvements in means for regulating pressure in electric mains." H. W. Butler. Dated February 22nd.

3,524. "Improvements in features for the anodes in electrolytic apparatus." W. P. Thompson. (H. Becker, France.) Dated February 22nd.

3,582. "Improvements in electric rollers for therapeutical and massage purposes." J. W. Gibbs. Dated February 22nd. (Complete.)

3,584. "Improvements in electric supply meters." Evershed & Vignoles, Limited, and S. Evershed. Dated February 22nd.

3,535. "Improvements in electricity meters and electric clocks." G. Hookham. Dated February 22nd.

3,561. "Improvements in electric ignition for internal combustion motors." W. J. Crossley and J. Atkinson. Dated February 23rd.

3,569. "Maximum demand indicators for electrical circuits." J. F. Moore, E. White, and J. M. Donkin. Dated February 23rd.

3,570. "Improvements in electricity meters." F. E. Berton. Dated February 23rd.

3,576. "Electric roundabouts." W. H. Pike. Dated February 23rd.

3,588. "An improved device for finding the electric poles." F. de Mare. Dated February 23rd.

3,607. "Wire frame for electric lamp shades." J. H. Cresswell. Dated February 23rd.

3,643. "Improvements in electrically-driven fans or air propellers." W. Tattersall. Dated February 24th.

3,665. "Improvements in or relating to the 'trolley-head' employed in connection with electrically-propelled cars or vehicles to ensure of the correct working position being effected when operated by the attendant to stop and start the said cars or vehicles and apparatus therefor." J. Fielding and E. Warburton. Dated February 24th.

3,683. "Improvements in electricity meters." H. Reason and The Reason Manufacturing Company, Limited. Dated February 24th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1897.

25,364. **"Improvements in electric switches."** V. G. Lirosi. Dated November 2nd, 1897. The base is formed with raised parts which support the ring for the handle. The movable contact arm is pivoted, and has split ends to engage the jaws of the fixed contacts. 2 claims.

25,368. "Improvements in electro-magnetic circuit breakers." W. G. Heys. (D. C. Spruance and M. Waddell.) Dated November 2nd, 1897. An electro-magnetic cut-out is arranged to open the circuit by mechanically breaking out a section between two terminals. A core suitably fixed is partly surrounded by a coil in the circuit under control, and its armature is carried by arms pivoted upon a spindle. This armature normally rests upon a rod, the distance of which from the core can be regulated by the ratchet. A wire spring or hammer is normally held by projections on a latch. When released it breaks a metal strip weakened into two or more pieces, so opening the circuit without danger of sparking. The latch is held in such a manner that its lower end engages a projection on a trigger lever, and is released when the armature, under the action of an excessive current, strikes a projection on the trigger lever. 11 claims.

25,386. "Improved compositions for use in the construction of electrical heating apparatus and resistances, and the processes for their manufacture." L. Parvillee. Dated November 2nd, 1897. Resistances are made from a mixture of plastic white clay, 40 parts, with nickel powder, 60 parts. The mixture is dried and shaped under heavy pressure in moulds. Parts where contacts are to be made are coated with a similar composition containing 90 per cent. of nickel. The articles are then baked with charcoal in closed receptacles, near the melting point of nickel. The contact parts may otherwise be electro-plated. The specific resistance of the articles depends on the fineness of the metal powder, the amount of compression, and the baking temperature. 4 claims.

25,403. "Improvements in or relating to current collectors for electric railways." A. J. Boult (T. A. Anderson and D. M. Anderson.) Dated November 2nd, 1897. Relates to electric railways and tramways on the conduit system. Collectors consist of two frame bars on each side enclosing insulated conducting bars held together by cross plates and bolts. Wearing plates are attached and supplied with lubricant from sight feed or other lubricators. Brackets are bolted to the lower ends of the frame bars, but are insulated therefrom and carry insulating blocks on which the shoes are mounted. These blocks have a pin-and-slot connection with the brackets, and are pressed outwardly by springs so as to follow any irregularity in the conductors. In a modification the shoes are mounted on bow springs, wires connect the shoes with the turned out ends of the conducting bars which are protected above by ledges of insulating material to shed water, &c. A fuse box or block is placed over the frame bar between the conducting bar and the lead to the motor. A fuse is placed outside an insulating cover and secured by thumb nuts. A switch is placed between the fuse and the conductor bar, for use when replacing a fuse. The collector is supported by bushed holes. 19 claims.

25,412. "Improvements in electrical resistances." T. E. Gambrell and A. F. Harris. Dated November 2nd, 1897. The invention consists in making resistance by applying finely-divided carbon mixed with a binding material, such as shellac or size, and a volatile solvent, such as methylated spirit or acetone, to solid insulators of ground glass, celluloid, ebonite or other material. Such a resistance may be mounted in a case with terminals. 1 claim.

25,420. "Method and apparatus for saturating, vulcanising and oxidising fibrous materials, in the production of material to be used for insulating and other purposes." F. Lamplough. Dated November 2nd, 1897. Relates to treating fibrous materials for insulating purposes. Fibrous materials, such as hemp, cotton, wood fibre, peat fibre, millboard, &c., are saturated in sealed vats with a mixture of resin, resin oil and unoxidisable fatty oil, such as fish oil, with or without the addition of sulphur, for vulcanisation. After saturation the product is allowed to drain and is slightly oxidised *in situ*. After removal, the product is pressed and allowed to harden, when it is ready for use for electric insulation and other purposes. The vats are preferably worked in pairs, any number of pairs being arranged together. The vats may be heated by steam coils or by gas jets; guide plates are used for causing circulation. The temperature is kept constant by means of a regulator attached to the reservoir containing water, alcohol, &c. The regulator consists of a divided chamber, the diaphragm of which is exposed on its upper surface to the pressure of the water, &c., vapour, while attached to the lower surface is a plunger for closing the gas or steam supply tube. The rod is raised by pivoted weighted levers. The fish oil is prepared by immersing fish in hot water without long boiling, the oil which floats being removed and purified. 6 claims.

25,582. "Electric lighter for gas and petroleum motors." H. M. L. Crouan. Dated November 4th, 1897. Relates to arc igniting device for gas or oil engines. A porcelain insulator of an electric pole is secured in the mounting by a screwed sleeve and asbestos washers. A space is left between the sleeve and insulator so small that no gas can be burnt and no soot deposited therein. The end of the insulator is covered by an asbestos washer and a metal nut to prevent the deposition of soot. 2 claims.

25,599. "Improvements in electricity meters." Chamberlain & Hookham, Limited, and S. H. Holden. Dated November 4th, 1897. Relates to quantity meters. A motor meter is provided with two field coils connected in different circuits, so that they cause the armature to rotate in opposite directions. If the meter is used to control the charging and discharging of accumulators, it may be made to run more slowly in one direction by using different field coils, or by shunting one coil with a definite resistance. A meter having an armature and two field coils, connected by a switch to a generator and also to an accumuulator and lamps is referred to. Discharge from the accumulator through the lamps passes through an armature and a coil, causing the meter to register. Current supplied from the generator to the accumulator passes through the other field coil and oppositely through the armature, so that the meter rotates oppositely. The invention is described with reference to continuous current meters with disc armatures in mercury. Another part of the invention consists in an adjustable shunt for the field coil of such a meter, or for other measuring instruments, and is made by permanently attaching a shunt resistance to the ends of the coil and clamping a circuit connection to the shunt near one end, its other end being permanently connected. 6 claims.

25,647. "An improvement in the manufacture of globes and shades for electric and other lamps." F. W. Dunlap. Dated November 4th, 1897. Relates to lamp shades and globes for electric and other lamps. A slender glass rod of circular or other suitable section is coiled whilst in a plastic state upon a heated mandrel, whereby the temperature of the glass is maintained at such a point that the closely juxtaposed convolutions coalesce or become welded together, the extent to which they are so united being just sufficient to constitute a rigid structure without materially impairing the lens-like properties of the rod. To overcome the difficulty of withdrawing the mandrel from bulbous globes or shades, either they may be formed in two parts which are subsequently welded before a blow-pipe flame, or the mandrel may be constructed and removed in sections. When the globes or shades are made in sections, glass rods of different colours may be used. 1 claim.

25,653. "Improvements in devices for or applicable to incandescent electric lamps." S. Bihellor. Dated November 4th, 1897. Relates to electric lamps, shades and shade holders. Coloured light is obtained from electric incandescent lamps by enclosing these in coloured covers of glass, celluloid, or other transparent material. In one form the cover is in two parts which are tied together at the bottom, and secured to the neck of the lamp by plates hinged together and provided with curved springs to grip the lamp, or by wire tied round them. In another form a ring is closed on the neck by a screw and carries angular springs with which a groove in a cover engages; or the springs may be formed to hold a flange turned outward on the edge of such a cover, on which an upper piece may rest to enclose the neck of the lamp. The covered lamps may be used in ordinary reflectors. 1 claim.

25,703. "Improvements in electrical batteries." W. W. Hanscom and A. Hough. Dated November 5th, 1897. The plates or electrodes are made up of a mixture of litharge and sugar made into paste with a solution of ammonium sulphate and moulded to a rectangular shape. The plates are then formed in the usual manner, after which they are compressed to a specified shape, the ribs being flattened. A metal rim with tapered edges and lug is then cast or burnt on to the plate. 8 claims.

25,723. "Improvements in alternating electric current meters." G. A. Schoeffer. Dated November 5th, 1897. Relates to energy meters for alternating currents. A conducting disc on a vertical spindle connected with a counter, rotates between a coil carrying the main current, and the two poles of a laminated magnet having coils connected between the mains. The disc also passes between the flat poles of a brake magnet. A thin iron plate clamped on a supporting rod near the disc, neutralises the effect of friction of the moving parts. The shunt magnet is adjustable horizontally to or from the vertical spindle, being clamped on a slotted support by a screw and nut. 14 claims.

25,744. "Improvements in alternate current induction motors." The British Thomson-Houston Company, Limited, and H. M. Hobart. Dated November 5th, 1897. Relates to alternating current motors. In order to facilitate the starting of an induction motor, the secondary element which may either be the rotor or stator, is furnished with two or more independent windings, one of which is permanently short circuited from one point, while the other can be either short-circuit from a point, approximately coincident with the former, or from the latter point, situated at a suitable angular distance therefrom. The latter condition is established when starting the motor, and the former when the motor has attained the requisite speed. For the purpose of adjustment resistances may be inserted in the short-circuiting leads. 4 claims.

25,745. "Improvements in reactance coils." The British Thomson-Houston Company, Limited, and H. M. Hobart. Dated November 5th, 1897. Reactance coils, having closed iron or other magnetic circuits are constructed so that accessible parts of the magnetic material may be altered to adjust their reluctance. In the form described the coils surround straight laminated iron cores, the ends of which are connected by bundles of strips; any desired number of these strips are iron, others being of non-magnetic material, such as zinc. 3 claims.

25,811. "Improvements in sockets or holders for electric lamps." S. H. Russell. Dated November 6th, 1897. A lampholder consists of a socket attached by screws to a casing, which is connected by a bayonet joint to a top piece and is lined with mica, enclosing the parts. A cylindrical insulator is perforated to receive the conductors, which are secured by screws to two bent plates, situated in recesses in opposite sides of the insulator. These recesses extend angularly downward and contain fuse wires connecting the plates with two metal strips. The middle of each fuse may be flattened or partly cut through. Separate recesses in the insulator contain parts of strips which extend down and carry a contact ring and an insulating disc. The strip opposite that shown extends to the disc and is connected to a central screw. This and the ring make connections with the lamp. The strip is bent over a rotatable switch which carries a stud to make contact with it and thus connect it with the strips which support the switch and the ring. A detaining spring secured under the strip bears on a rectangular part of the switch. 3 claims.

25,869. "An improved system for the distribution of electric currents and apparatus therefor." G. Moller. Dated November 6th, 1897. Relates to an improved system for the distribution of electric currents from any one of a given number of points to any other point through the medium of exchange. The main principle of the invention is to send currents of different strengths to the central apparatus, which consists of a number of relays or solenoids, the armatures of which can make contact with adjacent armatures, and so close local circuits. The arrangement of contacts and circuits are shown on diagrams which are too complicated for the purposes of abridgment. For a large number of subscribers the exchange is arranged in groups. A number board for use in this and other systems is described in the specification to indicate by means of discs what number a subscriber wishes to call when the second subscriber does not answer the signal. Instead of discs, type arms may be arranged to strike a strip of paper. The resistances on the number board are preferably arranged so that one of two arms represents thousands and hundreds and another tens and units. The system is applicable for telegraphy, the transmitters and receiving apparatus being modified for the purpose. 15 claims.

25,889. "An improved cell or box suitable for accumulator or other electric batteries." F. C. Geary and J. H. Robottom. Dated November 8th, 1897. Cells for electric batteries have near the bottom an orifice or orifices normally closed by plugs or lids to facilitate the cleansing of them. 1 claim.

25,890. "Improvements in or connected with electrolytic cells." G. Bell and G. W. Bell. Dated November 8th, 1897. The invention relates to apparatus for the electrolysis of solutions, especially of alkaline chlorides, to obtain alkali and chlorine by the use of a moving mercury cathode. In the example shown there are three tiers of compartments, the two outer sets containing (1) horizontal carbon anodes passing through stuffing boxes, (2) the electrolyte, and (3) a mercury cathode layer on the slightly inclined floors. Outlets for gas, arranged above the level of the electrolyte, and serving also as overflow pipes for the electrolyte, lead to two mains, each provided with a valve. The valves being shut, the pressure accumulates in the chambers as chlorine is developed during electrolysis, and the mercury amalgam formed is forced thereby below an amalgamated bar forming a lute and connected to conductors leading to the dynamo, &c. The amalgam then passes through glass tubes having U tubes or like gauges thereon, to the central tier of chambers containing water. The latter decomposes the amalgam, reforming the mercury and combining with the sodium to form caustic soda solution. The water enters the top chamber and overflows successively through tubes to the other chambers, finally leaving the the lowest chamber as a strong solution. Hydrogen is evolved during this reaction, and escapes through branch tubes to the main. The valve of one tube is then operated by any mechanism, and the chlorine allowed to escape. The pressure immediately falls in the chamber and the mercury flows back. Or the mercury may be driven back by allowing the hydrogen to accumulate in the vessels. The electrolytic action then recommences. By setting the two valves accordingly, the two tiers of chambers may be worked alternately. In the example shown the valve is closed or opened at fixed intervals by a double hydraulic tumbling basin charged with water from a supply tap. Other methods of operating the valve may be used, either electrical or mechanical. Strong brine is supplied to the chambers, the supply being regulated by a valve also actuated by a tumbling basin, and opened when the corresponding valve is opened. 9 claims.

25,941. "Improved construction of electrical transformers." C. Boritochewsky. Dated November 8th, 1897. The cores and frames are formed of undivided laminæ, and thus there are no joints. To wind on the coils, the bobbins are formed in two parts and fitted together on the core. They are supported on rollers so that they may be rotated by the pulleys. In a similar way transformers may be built up having two or more windings. 1 claim.

25,988. "Improvements in automatic circuit-breakers." W. Fairweather. (The Crocker-Wheeler Electric Company.) Dated November 9th, 1897. Relates to magnetic cut-out, which operates when the current exceeds or falls below certain limits. The circuit includes the coil of the magnet, a portion of the armature, and a contact. A second pivoted armature is provided, its position being adjusted by a screw. With a normal current the armature is held up to complete the circuit, its distance from the core being adjusted by a screw. When the current drops below the limit, the armature falls away and breaks the circuit. With an excessive current, the armature is attracted and closes the magnetic circuit and the armature again falls away. 1 claim.

26,023. "Improvements relating to electro-magnetic switch apparatus for railway signalling and other purposes." C. A. Allison. (W. C. Banks.) Dated November 9th, 1897. Relates to apparatus for switching into a circuit a second resistance should the first be short-circuited. The application of the invention to railway signalling is shown. An electro-magnetic switching device is placed between one terminal of the battery to switch in a resistance when the relay is short-circuited, as by a train standing on the rails. Two electro-magnet coils, the former of high resistance and the latter of low, are arranged in a circuit being normally short-circuited by a wire and spring. With a normal current the armature is not attracted, but when the resistance is short-circuited the armature is attracted, the point striking the spring and breaking the short circuit. In the preferred form of construction described, the core is double, and each leg is wound with two coils, one of high resistance and one of low, the former being normally short-circuited by the spring contacts. The armature carries an insulating finger which, when the armature is attracted, is forced between the springs, so breaking the short circuit. 10 claims.